NEWEST in layout boards is Plymouth's three-sided affair used to show its branch plants in Evansville and Los Angeles. Supported on trunnions, it can be tilted every 30 degrees for convenience in working on it. In the offing is Plymouth's "big board," on which the main plant's 1,110,622 sq. ft. of space is laid out to scale. Harvard thought it was so swell it ordered a duplicate board for its School of Business Administration. Look for missing details in a coming article.

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Factory

MANAGEMENT AND MAINTENANCE

June, 1938

Build Morale from the Top ..... an editorial 45

We Choose to Stay Small ..... H. Goldberg 46

What IS Production Control? ..... Geo. T. Trundle, Jr. 49

Ford Farmers 51

John Q. Supervisor Can Savvy This Bonus Plan ... J. E. Osterman 52

It's This Way in Washington ..... Carter Field 54

What Foremen Should Talk About ... John Richelsen 55

Motion Economy for All ... B. C. Koch and P. A. Robert 56

No Hit or Miss in This Job-Rating Plan ..... C. Fenton Raber and Robert M. Fox 59

Are Men Over 40 Ruled Out? 60

70° Cool Inside ..... Frank Elwell 73

$500 Down—Three Years to Pay ... Frederick A. Smith 76

Watch What You Ask of Your Power Drives ..... William Staniar 78

Errors Pushbuttoned Out ..... Arthur Van Vlissingen 80

219 Fires, But Only $60 Damage ..... J. R. Eldridge 83

We've Learned More About HIMV Lamps ..... J. H. Wenner 85

Multi-Motor Drives ..... R. F. Emerson 88

We'll Pay $500! ..... Following page 88

You Want to Know 92

What's New in Equipment 94

Operating Shorts 104

Trade Literature 134

Books 136

On the Calendar 138

also

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A Case in Small-Plant Layout ..... A. F. Murray 61

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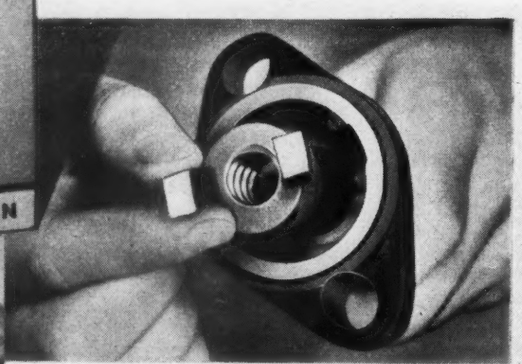

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Factory
Management and Maintenance
L. C. MORROW, EDITOR

Build Morale from the Top

GOOD EMPLOYEE RELATIONS are built from the top down. Only when human relations policies originate with an informed and sincere head of an organization do understanding and a spirit of cooperation permeate the entire personnel.

We talk much about the strategic position of foremen and other supervisory people. We recognize their close association with wage earners, and the influence they can have as parts of management.

But too often we overlook the fact that in the final analysis the supervisory forces are almost as far from management as are the wage earners. To them, as to the wage earners, the head of the organization—an individual—*is* management.

And when the head is not an informed individual in the matter of industrial relations, or when he is not sincere, or when he simply doesn't care, the whole organization knows it. Then there is likely to develop an attitude of indifference on the part of everybody in the outfit.

We raise the point at this time because somewhere ahead is another period of recovery. The labor front, relatively quiet now, will tend to seethe then. It seems to be just common sense that top management should do a sound foundation job now to prevent disturbances later. Except for a few flagrant exceptions, there is conclusive evidence that the organization with sound fundamental policies is least likely to have a devastating labor war.

Labor policies once determined, there is much argument in favor of putting them on record and making them known to all employees. Doing so is one way of removing the uncertainty that many employees now feel. Uncertainty is not good for employees any more than it is good for business. Uncertainty breeds fear.

Employee fear hinges about irregular employment, sudden lay-off, arbitrary discharge, seniority suspense, old-age idleness, the risks of organization and collective bargaining.

WITH SOME, if not all, of these matters company policies can deal. To the extent that they do so, in published statements, employee uncertainty is dispelled, confidence is built up, cooperation is engendered. A constructive job has been done by management—a job more than likely to pay for itself.

But it is better to have none of it unless the statements are sincere expressions of the considered policies of the head of the organization. To these policies the head must be willing to stick until the forces of progress and logic convince him that better policies should be substituted.

Alpha and omega of modern manufacturing—according to this small-plant can be worked off out of savings in a short term of years, but added men on

"We Choose to Stay

TELL THE small manufacturer about some principle that has been proved by experience to make money for the fellow who invented or adapted it. Says he, "Oh, that may be all right for Ford"—or Packard, or General Electric, or Pullman, you supply the name of the big company—"but it wouldn't be possible for a little outfit like ours."

But have a look at our statistics. We employ 28 men and we do every bit of work on our products except japanning, plating, and winding the motors. In business for 27 years. Four more factory employees than we had 12 years ago. Five times the production we had in 1925.

Larger corporations have a lot of committees and conferences to satisfy before they can make any radical improvements. But any time I want to do something so totally different that I'm afraid to take the full responsibility on my own shoulders, a five-minute talk with the president of the company gets it settled.

It usually takes less time than that, for he generally says, "Well, if you want to, why don't you do it? You make the product, I sell it. Why should I try to tell you what to do in the shop?"

We think that we are more progressive than any big company, and that we are progressive *because* we are small. Had we chosen to, we could have expanded this business of ours to many, many times its present size. We could have a sales volume ever so much greater than it is, and invested capital tied up in bricks and mortar and equipment far beyond our present figure—we could, that is, if in the interval we had been consistently fortunate enough not to take a licking.

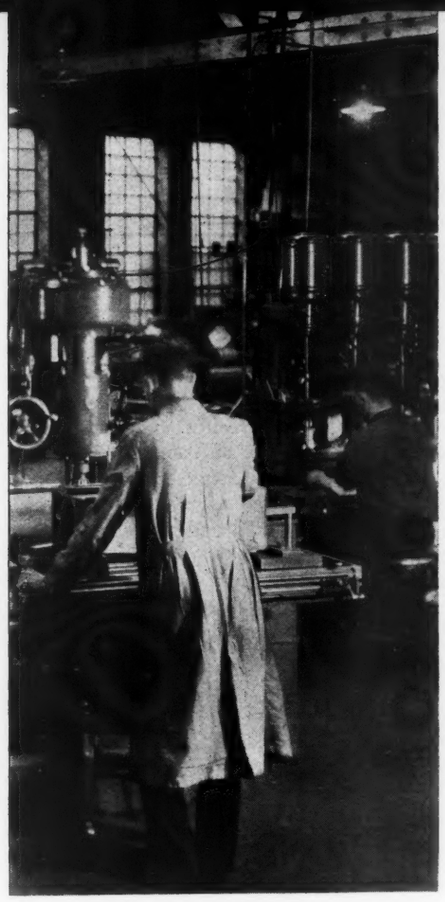
We have preferred to keep our size down to where we could be entirely self-contained, where our output would be good enough and small enough so that there would always be a demand for it beyond the supply. We have kept ourselves in financial condition so that we could at any time take advantage of any improvements in production equipment. And we have worked full time, with never a day of shutdown for lack of business.

We make two principal products—flexible-shaft portable tools, and a high-speed tapping machine. These are highly competitive fields, where price and quality are of great importance. To keep our costs down and our quality up, we pay our men annual salaries—not hourly wages, not piece rates or any other type of so-called incentive, but salaries—higher than any manufacturing business we know of.

Our lowest-paid employee is a stockroom boy who was hired two months ago at $18 a week, who now gets $20. By the end of 1938, if he keeps up his present level of good work and is still working in the stockroom, he will be getting $25 or $28 a week. The two men in our shipping room draw $30 and $35 a week respectively. On screw machines, we pay $40 to $46 a week. Our factory salaries run as high as $75 a week.

Probably your offhand reaction is that of most people when they first hear of this policy. To refute the idea that we are a charitable institution, let me say that we have made money every year of our 27 years in business, and that we have given full-time employment throughout all of these years. Yes, even in 1931 and 1932!

There is not even a semblance of philanthropy in our policies. We think we are good business men. We



enthusiast—is that the cost of a machine the payroll keep on costing money forever

Small"

Says the manager of this 28-man plant, where the best machine is none too good, where a five-minute talk with the president is all that is needed to reach even the most important decision

HERMAN GOLDBERG

Vice-President, R. G. Haskins Company
Chicago

are told by machine-tool makers that we spend more money, in proportion to the size of our business, than any other buyers of machine-tool equipment. In fact, the reason for our high wages is our plant equipment and the resultant high production rate per man employed.

If you know the type of manufacturing required for our sort of products, you can be astounded when you learn that we have no benches in our factory. There simply is no filing or touching up or hand-fitting in the place. Our policy is to supply the finest possible machines, keep them in the pink of condition, and man them with top-skill operators. Given a combination like this, there is no earthly reason why any part as it comes off the final machine operation should require more time or effort.

Proof that this works is in our record. Never has any part shipped to a customer failed to fit—if he ordered the right part. There is always, of course, the customer who orders No. 211 and then finds it will not go in because what he really needed was No. 311. But you cannot chalk that up against our machine production.

Consider our newest machine. It is a 6x8 grinder which cost us $8,000. It replaced the oldest machine in the shop. The old grinder was crowded at times—and we do not think it good business to crowd a machine to capacity and thus get service trouble.

So, we bought the new grinder, which does the grinding of the old machine, of the next oldest grinder also, and still stands idle half the time. The biggest grinding job we have in the shop is 1½ in. in diameter, but we bought the big grinder because we wanted the rigidity, the precision, that can be had most surely by doing work on a machine of far greater capacity. If ever we get up to work of, say 5 in., we shall get us a far larger grinder, so that we shall have the same sort of excess margin in the machine. This is the way to assure good work.

Our replacement schedule is always a surprise to outsiders. When a machine is seven years old, it is scheduled for replacement. But the machine-tool makers know that we will at any time, regardless of how old our present machine is, buy any machine that will give us the same output of better work or a larger output of equally good work. Also, on occasion, we buy a new tool that gives us the same output and the same quality, but lightens the workman's task.

Thus we never have any old machinery. We never utilize a machine's full capacity, either as to volume of work or type of work. Consequently, it is really news when we have a machine breakdown. Our machines are so young in years and so perfect in condition that when we sell them they average us 46 per cent of their original cost.

On Trial for Six Months

Not every man who asks for a job is competent to hold one with us. When we hire a new man, we put him on hourly rates for six months of try-out—high hourly rates, but still not our ordinary salary. We give him a try-out of at least six weeks. Frankly, despite the utmost care, we may have to let him go, try another, then another, and another, before we finally get a man who is competent to do our grade of work, and willing to take the full responsibility for production and quality.

Only three men have left us voluntarily in 27 years. Two went to take toolmaker jobs of extremely high standards, at the moment when we had no such openings. Most of our men, however, have been hired not as finished mechanics but rather as raw beginners. The bulk of our factory men came to work as youngsters in the stockroom, where they learned our line. The job of the stockroom assistant does not always keep a man busy eight hours a day so that he can at times help in some other department or perhaps even operate a milling machine in time.

Because of the type of men we get in this fashion, they are not satisfied to be merely lathe hands or milling machine operators. They want to know how to run all the machines in the shop. Within a very few years they know exactly this. Hardly a man in our shop is not competent enough to operate practically every machine tool we own. The toolmakers are, as a group, no more versatile or more skilled than the machine hands in the main shop. Nor, for that matter, do they draw any higher pay.

Another sidelight on our compensation policy—no man on our salary roll has drawn less than 55 weeks' pay per year in the past twelve years. Some of them have drawn as

high as 58 weeks' pay. Yet we pay no overtime.

The riddle is solved when you know our bonus policy. We shut down for a two weeks' vacation with pay, the first two weeks in July. At that time, I arbitrarily allot anywhere from one to three weeks' extra pay to each man in recognition of his production, attitude, and so forth. Also, at Christmas, we pay from one to three weeks' extra pay, depending on the man and his record.

Got What They Wanted

As has been stated, we pay no overtime. A few years ago, when it became evident that Saturday work was on the downtrend, we asked the men whether they would like to do away with Saturday working hours, and whether they could handle the work in five days.

After talking it over, they showed a preference for the Saturday shutdown. So they got it, and ever since they have maintained the same old six-day rate of output in five days. If a man falls behind with his work, he is likely to come back on Saturday morning. When we are particularly busy, it is not unusual to see eight or ten men working on Saturday morning. Mind you, this is not required of them; they do it of their own volition.

Throughout, the attitude of the men is exactly what you would expect of office men similarly well treated. They take full responsibility for quality and quantity of work. We have no inspectors. We need none. I spent most of my time out in the shop rather than in my office, but I am not there as a driver. I am trying to find better ways to do things, to help the men to increase their output and thus make it possible for the company to pay them even higher salaries than they now get. We make them *want* to produce as their recognition of treatment better than they could easily find elsewhere.

Our policy is to get the men to produce just as much as they can produce—not by driving them, or urging them, or putting bait to lead them on like a carrot before a donkey's nose. We give them the most modern and productive equipment, thus making it possible for them to turn out more goods than is possible in any other shop where we know comparable precision is required. We save money by doing away with expensive supervisory costs.

Our tribute to the new economics comes in paying these men a fair share of this high production. We are in no sense critical of the manufacturer who pays his men less than we pay, whether by the hour, the week, or the year. Conditions in his industry or his plant may be far different from what we encounter, and he is probably doing the best he can. But we feel it is good business, first to get big production from our men, second to give them big pay commensurate with what they produce. Thus they become better consumers, buying more of the products from people who need our goods to produce.

We have given year-around employment to a force of men for 27 years, gradually increasing the working force—very gradually. In that time, we have doubled and redoubled our output of goods, thus making it possible to pay the men more money for making the goods and to give the customer—general price levels and quality considered — a better product at a lower price.

We have almost exactly the same number of machines we had fourteen years ago. But our production is many times as great. Obviously, we have reached this point by using ever more productive machine tools. We do not buy a duplicate unit when we need more capacity. Instead we buy a bigger, better unit which retires the old one and still gives us double or triple the output. For the *alpha* and *omega* of modern manufacturing is that the cost of a machine can be worked off out of savings in a short term of years, but added men on the payroll keep costing money forever and ever.

Three Sets of Tools

This is why we have always the best and most productive machines. It is the realization that down-time is sheer waste that prompts us to buy three sets of tools for every new machine even though we know the chances are we shall eventually turn over one set of brand-new tools to the second-hand purchaser. And we get our money back a dozen times over for spending it on safety-first replacements.

Anybody who has read thus far knows our ideas—and the results they bring us—just as well as he would know them after reading as many words again. For—they do bring us results. These policies pay us, pay us every step of the way. They are, after all, merely carrying out to the *nth* power the ideas that most progressive American manufacturers believe in general terms. And, if they accomplish nothing else, they should give anyone adequate ammunition to fire at the fellow who says. "Oh, it may be all right for U. S. Steel, but my little business couldn't stand it."

It's this successful small shop's firm intention to keep its size down to the point where it can be self-contained, where its output will be good enough and small enough so that the demand for it will always exceed the supply

What IS Production Control?

Arithmetic and horse sense. You see it work in any symphony orchestra. Or, to switch figures, the assembly room is the Grand Central and it's your job to see that all trains arrive on time

GEORGE T. TRUNDLE, JR.
President, The Trundle Engineering Company
Cleveland

PRODUCTION control means, literally, controlling production and all factors entering into production instead of letting production run wild. And yet—perhaps because the term has come to have a more or less semi-technical meaning in industrial engineering procedure—many business men have come to regard "production control" as something highly complicated and mysterious, which only a mathematical wizard could understand and an industrial genius put into effect.

This is not the case at all. Production control is simply the application of plain common sense to the solution of those responsibilities of management which have to do with increasing productivity and decreasing operating costs. It consists of getting certain necessary facts, and then planning on the basis of those facts.

Perhaps the easiest way to describe the significance of production control is to imagine what would happen to a transportation system if there were no time tables.

Suppose a Train—

A railroad, like any other business, is engaged in producing a commodity. That commodity is transportation. What would happen if transportation were produced without reference to a plan? Suppose a train simply started when the engineer felt like it, and arrived at its destination when it happened to get there.

Suppose passengers who wished to make connections with another train had not even a guess as to when they would reach the connecting point; or whether or not when they arrived there, the train with which they wished to connect would have left, or would not show up for two hours.

It is not by accident that trains are on time—that trains make connections. It takes infinite detailed planning to accomplish this purpose—and this goes far deeper than mere schedules. It involves the condition of locomotives, cars, and tracks. It involves the quality of materials that go into this equipment. It involves the skill and reliability of railroad employees.

•

For plant operating men in the making, an enlightening exposition of a subject that can be made to seem pretty complicated. For those who have been around a long, long time, just a reminder that maybe they are doing the job only half as well as they already know how

•

It involves a reasonable allowance for unanticipated minor delays. And yet so carefully have all these things been worked out that, in ordinary practice, when a train is late we are surprised.

But, in industrial production, are we surprised when "a train is late"? Are we surprised when the press in a print shop is kept waiting because the cutter is slow on the cutting machine? Surprised when presses in a parts plant are idle for hours because the purchasing department was late in ordering and materials have not yet arrived? Surprised when work in an assembly room must be stopped for a half day because production is behind on part 37?

Our firm had occasion not long ago to study the production situation in a certain plant—get the necessary facts, make plans in accordance with those facts, and set up "production control". Our experience in this particular plant will serve as a typical illustration of the difference between controlled and uncontrolled production.

When we first went in we found a situation which would be paralleled only if every train coming into the New York Grand Central Station were an hour early or an hour late. In short, nothing made connections. Each operation seemed to be running gayly along, independent of anything else.

To be specific, some thousand-odd men were put to work every morning on whatever jobs the various foremen thought needed to be worked on. There was no statistical evidence as to what jobs needed most to be done, or how much labor was required.

The plant manufactured a household device, involving several hundred parts. Invariably the plant turned out too many of some parts and too few of others. Consequently they never came out even in the assembly room. Some days they turned out a great many of the finished product, some days only a few. The amount to be produced in a week or a month was literally a matter of speculation.

There was similar lack of coordination in the routing of production through the plant, and in the storing and handling of materials. Equipment was awkwardly arranged apparently for no reason except that it had been arranged that way in the first place. Parts piled up in the wrong places, and nothing was done about it because it had never occurred to anybody to do anything about it. Inventory, largely in parts and work in process, was constantly accumulating in an unbalanced condition, unnecessarily tying up working capital.

No Purchasing Plan

This situation went clear back to the purchasing of materials. There was no planned purchasing. When a supply of one type of material threatened to run out, the purchasing agent bought some more. He might buy a small amount or a large amount, depending upon what was offered, what he guessed might be needed, and what price advantage was offered by vendor on quantity.

He had no rigid specifications for

materials, with the result that there was undue variation. This showed up in the shop. For instance, dies adjusted to one type of steel were suddenly confronted with a lot of a quite different type. The result was needless spoilage. In some cases 30 per cent of the production of one type of parts went into the junk heap.

No Second-Rate Outfit

Do not for a moment get the impression that this was a second-rate company with a second-rate product. Its product was an excellent one. It had an established reputation and established markets. But, like many another company, it had not yet brought its operating efficiency up to the standard required under modern competitive conditions.

What that plant needed was controls. It got them within a period of comparatively few months. The net result was that the plant raised wages and cut hours—yet turned out a larger volume with fewer men on the payroll and at a lower cost.

How was this accomplished? By following the basic principles that are necessary to the establishment of controls in *any* manufacturing plant. The procedure is, in the main, as follows:

1. Establish the desired volume to be produced. No intelligent planning can be done in a plant except on the basis of anticipated output. This means going to the sales department and getting a carefully conceived sales estimate. Of course the amount arrived at does not have to be rigidly adhered to. But some fixed amount must be established, at least as a yardstick, in gaging operations all the way to finished product.

2. Determine specifications. There should be definite specifications for all the materials entering into the product; specifications for each part entering into the final product; specifications as to the degree of machining, finishing, or other characteristics of the various parts. All of this information should be obtainable by working with the engineering department. When this job is done, it will have set standards for raw materials, for manufacturing processes, and for finished product—and the job then becomes one of arranging operations to conform to these standards.

3. Check tools and equipment. Definite specifications for the product and its various parts have been determined. The question now is, "Are tools and equipment capable of turning out a job that will meet these specifications on the basis of the materials to be supplied?" If investigation shows that some of the equipment is not capable of functioning properly, new and suitable equipment must be supplied.

4. Determine standards of work. With specifications definitely set and with equipment and tools in proper shape, the next job is to determine as nearly as possible the amount of productivity to be expected on each particular job. Obviously, production cannot be properly coordinated—like the trains that meet in a railroad station—unless rate of production of various items is reasonably ascertained in advance. In fact until standards of work are determined there is no accurate way of estimating how many men are going to be needed to perform the work.

Any Good Farmer Can Tell

It is our experience that work standards can be established satisfactorily for all practical purposes without going too deeply into time study. Neither does our experience show us that the piecework system or some other incentive method is needed in order to gage accurately what should be the productivity of a good man on a certain job. It has been argued that piecework is a device whereby the worker may make up for inefficient management—and there is considerable to be said for this point of view. After all, knowledge of equipment and men, and plain common sense, point fairly accurately toward proper standards of work.

Any good farmer who knows nothing of piecework or time study can tell about how many acres a good man with a good team should plow in a day. Similarly, a good shop executive, with the aid of past experience and information supplied him by equipment manufacturers, who know quite well the output to be expected from their own machines, can set up work standards which, for all practical purposes, should be sufficient. The job is one of knowing the capacity of equipment in relationship to the material to be handled, and then making proper allowance for the human element.

5. We now have the essential and known factors with which to work. We know the exact nature of the raw materials, the specifications covering all items to be produced, the equipment needed to produce such items in accordance with specifications. And work standards specifying how much time it will take to turn out a given number of every item. With this foundation, planning and scheduling becomes a matter of arithmetic and horse sense. For production purposes the assembly room becomes the Grand Central Station. The job of planning and scheduling is simply one of seeing to it that all trains arrive at the Grand Central at the same time.

That, in substance, is "production control." There are many secondary items into which I might go in detail, such as the advantages of good lighting, whch helps men do better work, proper storing and arranging of materials, which saves time and effort, or the routing of materials through the plant in such a way as to make for minimum handling. But all these things become obvious as soon as the main principle of the thing is once grasped and the effort made to put it into effect.

It is hard at first for some people to understand the fact that production control with respect to a specific item of manufacture is not confined to the physical work on that particular item, but must embrace control of *all* the factors that have a bearing upon the production of that item.

With thorough controls established you know that supplies and materials are right, that specifications are right, that equipment and facilities are right, that the number of men employed is right, that products will be produced, ready for delivery at the right time; and that work in process and inventory are balanced so that no excess working capital is tied up.

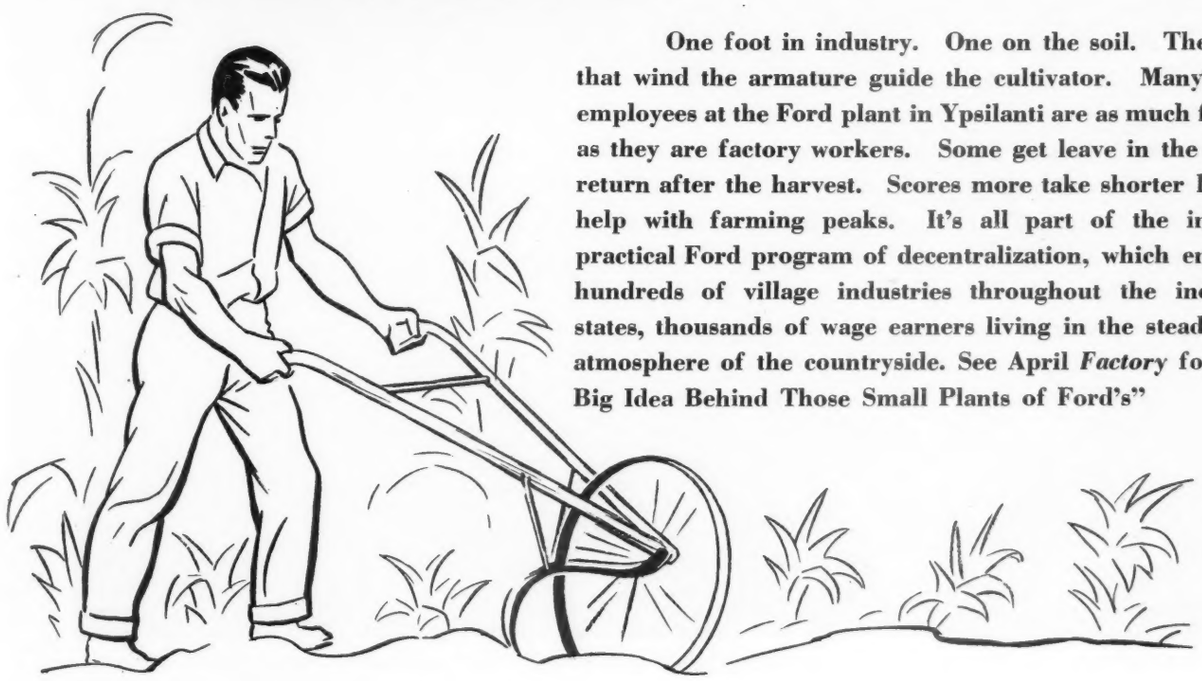
See It at the Symphony

Do not get the impression from the above that production control is easy. It is not easy. It involves digging into facts and figures, overcoming the lethargy of plant executives, educating foremen to new ideas, training workmen to different ways of doing things. But the principle of the thing is simple. You can see it perfectly at work in any symphony orchestra.

Imagine, if you can, an orchestra all set up—instruments in place, music on each rack—and then suppose every musician started playing his part at his own particular tempo. How would it sound?

But music isn't played that way. There is a conductor who keeps time. There must be timing and coordination, or the result is not music. And in manufacturing, there must be timing and coordination directed by "production control"—or the result is not profits.

Ford Farmers



One foot in industry. One on the soil. The hands that wind the armature guide the cultivator. Many of the employees at the Ford plant in Ypsilanti are as much farmers as they are factory workers. Some get leave in the spring, return after the harvest. Scores more take shorter leave to help with farming peaks. It's all part of the intensely practical Ford program of decentralization, which envisions hundreds of village industries throughout the industrial states, thousands of wage earners living in the steady, sane atmosphere of the countryside. See April *Factory* for "The Big Idea Behind Those Small Plants of Ford's"

John Q. Supervisor Can Savvy This Bonus Plan

Tricky formulas never make, more often unmake, the supervisory bonus plan. Here's one every foreman in the shop can understand and figure out for himself. It's based on over-all performance

J. E. OSTERMAN
Industrial Engineer
General Household Utilities Company
Chicago

MANAGEMENT has given a lot of thought to the subject of supervisory bonuses. A few years ago a great deal was written on the subject. Tricky formulas involving complex mathematical equations, often understood only by their inventors, and usually misunderstood by their beneficiaries, appeared on the horizon, had their day, and then silently passed into oblivion.

The very short span of life enjoyed by many of these well-intentioned plans can usually be attributed to one major fault—they had no definite objective, no firm foundation.

Additional compensation paid to a foreman or supervisor in the form of a bonus, in fairness to all concerned, management and the supervisor alike, should be based on a foundation of results and over-all performance, and be used as a vehicle to promote better performance and more favorable results.

Any plan that pays the supervisor a bonus based upon savings effected through his earnest efforts is a good plan. However, very few plans devised to date completely cover the entire range of supervisory functions.

Setting a Bogey

All factors of supervision having any bearing upon supervisory performance, good or bad, should have a place in the bonus scheme. A bogey, or allowance, should be established for each factor as a target to shoot at. Rewards or penalties should be contingent on the results.

Some of the best management yardsticks, factors that should be considered in every good bonus plan, set up in the order of their importance and graded as to value, would, in the average case, appear as follows:

1. *Departmental Efficiency*—Critical evaluation of departmental efficiency as reflected in costs, workers' earnings, etc.—50 per cent.

2. *Budgetary Control*—Based on condition of departmental operating-expense budgets—15 per cent.

3. *Quality Control*—Based on condition of scrap and rejected materials as compared to the amount of good materials produced—15 per cent.

Making it possible for the foreman of this assembly department to earn a bonus, resulted in better control of costs

If she winds radio coils quickly, without spoilage, she earns more, and her supervisor gets a bonus

4. *Control of Excesses:*

a. *Excess Daywork*—Control of excess daywork allowances made to incentive-plan groups over and above regular allowances—5 per cent.

b. *Excess Overtime*—Control of excess overtime due to poor planning and mismanagement on the part of the supervisor—5 per cent.

c. *Excess Materials*—Control of productive materials requirements in excess of specified quantities—5 per cent.

5. *Base Rate Control*—Control of base rates, operating within or under standard base rates established for the various tasks of the department—5 per cent.

Other elements of supervision, such as deliveries, consistency, good-housekeeping, should be considered in the bonus plan if deemed of sufficient importance.

Reward for Performance

Figure 1 illustrates an analysis of a hypothetical supervisor in a piecework department according to the gradings outlined above. This analysis is designed to reward in direct ratio to good performance, and penalize as the occasion demands.

We have applied this bonus plan in our plant, finding it simple, well balanced, and effective.

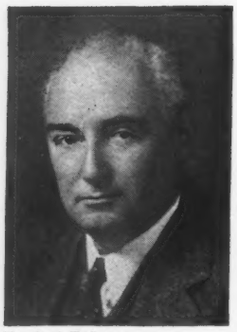
SUPERVISORY BONUS ANALYSIS

DEPARTMENT "A" JOHN DOE, SUPERVISOR APRIL, 1938

Elements	*Grade*	*Extension*	*Penalties*	*Bonus*
a. Department Efficiency	.50			
b. Budgetary Control	.15			
c. Quality Control	.15			
d. Excess Daywork	.05			
e. Excess Overtime	.05			
f. Excess Materials	.05			
g. Base Rate Control	.05			
h. Supervisor's Salary		$200.00		
i. Department Efficiency		125.00%		
Bonus = (i — 100%)ha = 0.25 x $200 x 0.50				$25.00
j. Budget Allowance		$600.00		
k. Budget Expended		$500.00		
Bonus = (j — k)b = $100 x 0.15				$15.00
l. Scrap Allowance		$500.00		
m. Actual Scrap		$550.00		
Bonus = (l — m)c = —$50 x 0.15			$7.50	
n. Allowed Daywork		$50.00		
o. Actual Daywork		$25.00		
Bonus = (n — o)d = $25 x 0.05				$1.25
p. Allowed Overtime		$50.00		
q. Actual Overtime		$75.00		
Bonus = (p — q)e = — $25 x 0.05			$1.25	
r. Excess Materials Allowed		none		
s. Actual Excess Materials		$10.00		
Bonus = (r — s)f = — $10 x 0.05			.50	
t. Labor at Standard Base Rates		$2,500.00		
u. Actual Labor		$2,450.00		
Bonus = (t — u)g = $50 x 0.05				$2.50
Total			$9.25	$43.75
Net Bonus Paid				$34.50

Note: All negative results become penalties

Figure 1. How the hypothetical John Q. Supervisor computes his bonus



Harris & Ewing

It's This Way in Washington

Business of marching uphill and down—as usual labor can't deliver votes—Lewis fades as political menace—prospect for sane congressional action better than for a long, long time

CARTER FIELD

Washington Correspondent

THERE HAS been a lot of marching up the hill and down again since last month, when the opinion was ventured here that "follow the leader" was no longer a political necessity for congressmen in voting on measures affecting business.

Net result of all the marching is pretty nearly zero. Pennsylvania, where the New Deal lost not only its shirt but also its reputation for infallible political prediction, just about offset Florida, where a pro-New Deal senator triumphed over an ND critic seeking his toga.

A good many more cards will be played, in various states, before the picture is complete, and it would be dangerous now to predict that New Deal ideals will not be slavishly followed by a chastened Congress after the primaries and the November election have recorded their mandates. *But*—present conviction in Washington is that the results will be mixed, with Administration victories and defeats so counterbalancing that the net result will be, next session, that individual senators and representatives who *want* to be independent *will* be.

More important is what hit John L. Lewis. Regardless of what may happen to the Roosevelt prestige, it would seem next to impossible for John L. Lewis again to inspire the political fear in congressional breasts that has dwelt there for the last few years. By the same token William Green and AFL have regained the prestige and political power they enjoyed up until Lewis and CIO moved in on Roosevelt.

Even with Farley's support, with all that this implied as to White House preference, Lewis failed to get to first base. Not only that, but his main threat—that he might bolt to Gifford Pinchot if his man Kennedy were not nominated for governor—was proved a joke by the fact that Judge James gave the former TR Progressive a bad trouncing.

No Record of Delivery

Incidentally, a lot of business men and politicians would like to know if this battle between CIO and AFL really had much effect. There is no way of telling. But it is just barely possible that even if *both* labor outfits had been on the same side they might not have won.

It is a strange fact in our political history that there is no single case where it can be clearly demonstrated that the labor vote was delivered by its leaders. There are lots of cases where proof is attempted—for instance when Simeon D. Fess defeated Atlee Pomerene for the Senate in Ohio years ago. But examination of the facts always discloses that there were other factors which, to some investigators, seem more important.

In the Pomerene-Fess case, which is the one labor leaders point to with pride, it just happens that the Anti-Saloon League was at the peak of its power, and that in every evangelical pulpit in Ohio, the Sunday before election day, ministers denounced Pomerene as a "Wet." As this was shortly after a drastic search-and-seizure dry enforcement law had been approved by Ohio's electorate by more than a quarter of a million, one might be pardoned for suspecting that prohibition had as much to do with Pomerene's defeat as his labor record.

Important now, however, is the fact that the labor outfit that has been dominating New Deal policies and New Deal appointments turns up as a political loser.

Shrinking of the Lewis political menace in the minds of our national legislators has also resulted in many members of House and Senate paying more attention to the flood of protests from manufacturers as to the high-handed methods of the NLRB.

There is plenty of reason for these protests to interest Congress. After all, Congress has barely finished repudiating President Roosevelt's pet ideas of reform through taxation. In taking this radical political step the individuals so voting were actuated almost exclusively by the argument that a change was necessary to give business a chance.

Now Congress is being told, emphatically, that the labor policy of the government is also a wet blanket on enterprise, and particularly on any contemplated expansion—that it is one of the big contributing causes of unemployment. Up to now it has not been a question of disbelieving this contention. But individual congressmen, with their eyes on primaries and election this year, were timid about making any move that might bring a strongly organized group out against them.

This timidity might still exist if Green and AFL approved of NLRB. But the congressman must make up his mind either that the labor vote is important to him or that it is not. If he makes up his mind that it *is* important to him, then the present situation is that, in the state in which Lewis and CIO were considered strongest, Green's group proved greater strength.

Interesting, either in this connection or in speculating whether labor leaders deliver votes at all, is the fact that the coal mining sections of Pennsylvania seemed to go along with the rest of the state in administering a walloping to the Lewis candidates.

Altogether, the prospects for sane action by Congress in passing legislation affecting business—always excepting the utilities—are less gloomy than for a long time.

What Foremen Should Talk About

Don't let either the wild-eyed agitator or the smug capitalist tell you what you should think

JOHN RICHELSEN
Personnel Director
Vanadium Corporation of America
Niagara Falls, N. Y.

A FOREMAN naturally talks to his men about their particular jobs, the right way and the efficient way and the safe way to do what they are being paid for doing. The topnotch foreman makes his record through ability to hold his crew to the fair daily stint. When he can do this by leading his men, without having to drive them, he is a valuable man. His future is ahead of him, not behind him.

There is so much being said about industrial concerns trying to coerce the wage earner that one hesitates to suggest to the foreman that he should be the teacher to his men even on so obvious and so glorious a subject as that of the workingman's privileges and possessions in our own U.S.A.

Let me put it this way to American foremen. Don't let either the wild-eyed agitator or the smug capitalist tell you what you should think or what you should say to your men. But you should make up your own mind about the facts. And if you are thoroughly convinced that your country, even with its acknowledged faults and shortcomings, is nevertheless a land of vast privilege and advantage in comparison with European countries, your next move cannot be uncertain. You are in a place of leadership, and you ought to make your abilities and your position count for the things you believe in.

Nobody wants to be preached at, and that isn't what is being proposed. But when a man believes something strongly enough, he gets across his opinions and conclusions —unless he is a clam or a hypocrite—without much direct talk.

Unfit for Leadership

I shall not presume to tell you foremen what your convictions should be, but I must assert that you and I ought to have convictions about America. If our convictions are decisively favorable to our country, we are weak sisters, utterly unfit for the leadership of our jobs, if we don't make them carry weight with those we come in contact with.

How, for instance, does America stack up with Europe?

Let's take things that might be classified as luxuries in poorer countries—radio receiving sets, telephones, electric lights, insurance, railroads, and automobiles. In Europe $69 worth of insurance is owned by the average person; in America the average is $864. America has one mile of railroad for every 500 persons, Europe for every 2,000. Europe has one radio set for every 17 persons; America one for every 6. America has one telephone for every 7 persons, Europe one for every 35. In Europe 10 out of 75 are electric light customers; in America, 10 of every 50. Europe has one automobile for every 59 persons; America, one for every 5 persons.

Now let's do our own thinking about our material advantages in America. And we're poor sticks if we can't open our mouths about the conclusions of our thinking. And such conclusions will have to do not only with what we have, but also with how we got this way.

Foremen in industrial plants, if they are square shooters, have the confidence of their men. The vast majority of foremen were not born with silver spoons in their mouths, but have come up from the ranks by hard work. The men know that the foremen have the workingman's viewpoint. Probably nobody in America has a more enviable position of influence with the great group of wage earners than has the foreman.

Motion Economy for All

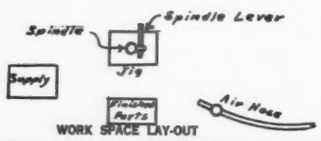
Courses were given first to 200 key men, later extended to machine operators and other shop employees. Example shown here is typical of the projects used in this work

B. C. KOCH
Standards Supervisor
and
P. A. ROBERT
Factory School Supervisor
International Business Machines Corporation
Endicott, N. Y.

FORM 1230 REV. ENG.

PROCESS CHART
Old Method

PART NO. 136058-0 OPER. NO. 65
DEPT. NO. 3 MACH. NO.
DATE 4-28-36
DESCRIPTION OF OPER. Spot-face



WORK SPACE LAY-OUT

LEFT HAND	RIGHT HAND
Grasp piece	Blow out jig
Move to jig - 6"	Release air base
	Move to jig - 4"
Locate piece	Locate piece
Hold piece	Swing clamp into place
	Tighten thumb screw
Grasp jig	Move to spindle - 12"
	Grasp spindle
Hold jig	
	Lower spindle
	Spot-face
	Raise spindle and release
	Move to thumb screw - 12"
Release jig	
Grasp piece in jig	Release thumb screw
	Swing clamp aside
Move piece to finished parts 4"	
	Move to air base
	Grasp air base - 10"
Drop piece	
Move to supply - 6"	
	Move air base to jig - 10"

DISTANCE MOVED	16	INCHES		DISTANCE MOVED	48	INCHES	
NO. MOVES	3	NO. OPERATIONS	6	NO. MOVES	5	NO. OPERATIONS	12
NO. IDLES & HOLDS	2	NO. ELEMENTS	11	NO. IDLES & HOLDS	0	NO. ELEMENTS	17

TOTAL DISTANCE MOVED	64	TOTAL MOVES	8	TOTAL OPERATIONS	18	TOTAL IDLES & HOLDS	2
TOTAL ELEMENTS	28					TOTAL TIME PER PIECE	.133 MINUTES

PREPARED BY DATE

IN A SERIES of articles that appeared in *Factory* in the summer and fall of 1936, Prof. Myron A. Lee of Cornell University described how a motion economy program was initiated at the Endicott factory of the International Business Machines Corporation.* Professor Lee described the first phase of this program, which involved discussion courses for approximately 200 factory foremen and their assistants.

During the past year this program has entered, and is still progressing through, another phase, under which the motion economy discussion classes have been extended to nearly 600 factory employees. To date, 547 of our employees have voluntarily enrolled in and successfully completed this course. Only 41 of those who enrolled failed to complete the course.

In accordance with typical motion economy technique we present herewith the "Why? What? How? Who? When? Where?" of this project.

Why Motion Economy?

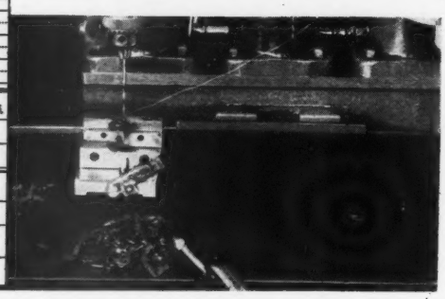
Originally, we decided to extend motion economy discussion courses to machine operators and other shop employees because some of our foremen requested it. One foreman in particular who had completed the course asked, "Why can't my men take this course? They all should have it!"

Other foremen made similar requests, the idea gradually spreading as the results became more evident. Some of the reasons given by the foremen for these requests were:

1. These courses help take a lot of the mystery out of the time-study man's work, thus improving the morale of the employees.

*"200 Key Men Took Motion Economy," July, Sept., Oct., 1936.

Figure 1. A drill-press operator enrolled in the course worked out this project. Here is the old method of spot-facing the pawl shown on the opposite page. Note not only total moves and operations, but also distance moved by the operator's hands



2. They stimulate employees to give more thought to their everyday jobs, thus increasing interest and improving the jobs.

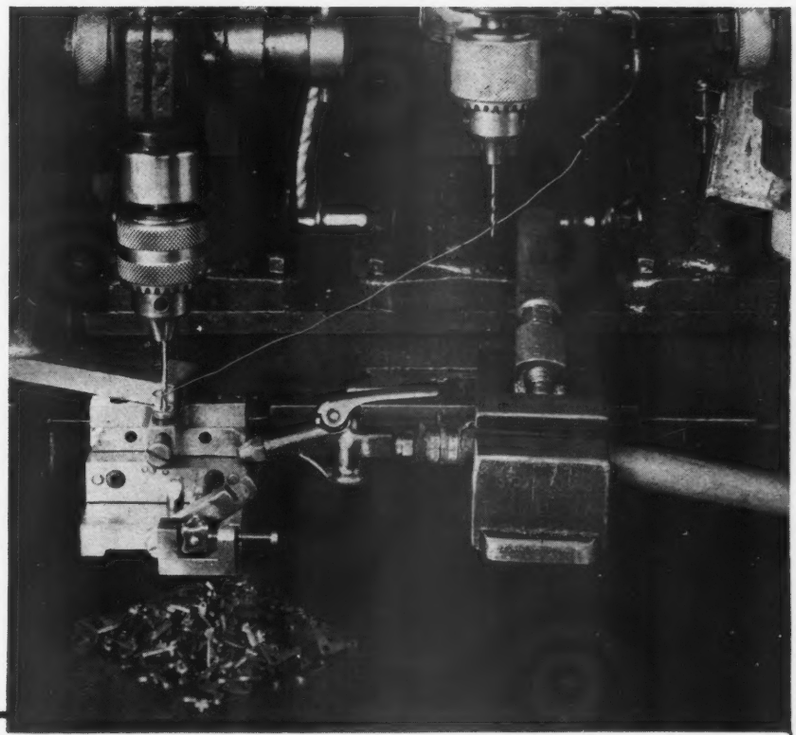
3. A knowledge of motion economy principles helps make safer workers, by reducing fatigue and eliminating unnecessary motions.

4. The general effectiveness of the department and of each individual in it is improved by these discussions.

What Material?

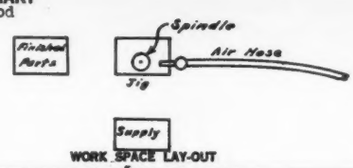
The material used in these discussions for employees is essentially the same as that used in the foremen's courses. Primarily this is a project course. The printed lesson material is used only for reference. The discussions are devoted to illustrating the application of these principles to specific jobs on which the employees comprising the class work every day.

(Continued on page 132)



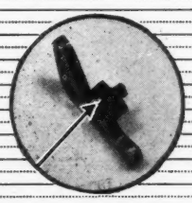
PROCESS CHART
New Method

PART NO. 136058-H OPER. NO. 65
DEPT. NO. 3 MACH. NO.
DATE 6-9-36
DESCRIPTION OF OPER. Spot-face



WORK SPACE LAY-OUT

LEFT HAND	RIGHT HAND	RIGHT ~~HAND~~ FOOT
Move to jig - 6"	Release thumb nut	Raise spindle
	Swing clamp aside	
	Continuous air blast blows part out of jig	
	Hold clamp	Idle
Locate piece		
	Swing clamp into place	
Move to supply		
	Tighten thumb nut	Lower spindle
Grasp new piece	Hold thumb nut	Spot-face



DISTANCE MOVED 12 INCHES	DISTANCE MOVED 0 INCHES	DISTANCE MOVED 0 INCHES
NO. MOVES 2 NO. OPERATIONS 2	NO. MOVES 0 NO. OPERATIONS 4	NO. MOVES 0 NO. OPERATIONS 3
NO. IDLES & HOLDS 0 NO. ELEMENTS 4	NO. IDLES & HOLDS 2 NO. ELEMENTS 6	NO. IDLES & HOLDS 1 NO. ELEMENTS 3

TOTAL DISTANCE MOVED 12 TOTAL MOVES 2 TOTAL OPERATIONS 9 TOTAL IDLES & HOLDS 3
TOTAL ELEMENTS 13 TOTAL TIME PER PIECE .050 MINUTES

PREPARED BY DATE

Figure 2. New method adds some footwork, cuts moves from 8 to 2, operations from 18 to 9. Most important, although production was increased from 429 to 1,141 pieces per hour, distance traveled by hands was cut in half

No Hit or Miss in This Job-Rating Plan

Over 20 gradations in the six requirements common to all jobs can be used by the job analyst, and his rating is checked by both supervisors and employees

C. FENTON RABER
Personnel Manager
and
ROBERT M. FOX
Industrial Engineer
American Box Board Company
Grand Rapids, Mich.

WHAT'S a job worth? How much should a millwright helper, who must have certain educational qualifications and bear some responsibilities, be paid, as compared with a full-fledged millwright whose job demands different amounts of the same qualities and some elements of supervision besides? Job analysis and classification is the tool with which the answer is worked out.

Before we put our new plan into effect, supervision had always used judgment in deciding whether one job should receive a higher rate of pay than another. Jobs were classified with high and low rates for each. Supervisors analyzed requirements much as they do now, paying particular attention to the job's physical requirements and the responsibility for errors and mistakes. But in these explanations there was always a chance that important points would be left out, and a tendency on the employees' part to emphasize some features of their work that might occur only at irregular intervals.

No new principle is involved in our present plan; it is intended as an aid to judgment, not a substitute for it. The only change in procedure is that supervisors and employees now exercise joint judgment in rating jobs. It is recognized that many occupations in a department are similar to those in other departments, and unless each occupation is analyzed and classified rates of pay are likely to vary for occupations deserving the same rate.

First step in development of our classification plan was to determine those characteristics that are important in evaluating the worth of an occupation. See Figure 2.

At this point we had to fix a relationship between rates and characteristics. To illustrate in round numbers, assume we had a starting rate of 50 cents per hour. We arbitrarily multiplied it by four to establish 200 points as the point value of the starting rate. One point, therefore, is the equivalent of ¼ cent. This job at the starting rate, it must be noted, does not call for any exercise of the above characteristics other than that expected of a green employee.

Assuming further a maximum rate of $1 per hour, then 50 cents or an additional 200 points were available with which to express the importance of these six job characteristics.

Four hundred points were then the equivalent of the maximum rate and each point represented ¼ cent.

Spread Six Ways

The flexible 200 points are spread over the six characteristics according to their importance. It was observed that from 2½ to 7½ cents per hour more was paid for supervisory jobs than for jobs demanding less of that characteristic. Multiplying the maximum, or 7½ cents, by our four points established the point value of 30 for supervision. Practically the

RATE COMMITTEE

AMERICAN BOX BOARD CO.

CLASSIFICATION AND RATE SHEET

DATE

OCCUPATION	SUPERVISION		RESPONSIBILITY		TRAINING		INITIATIVE		COOPERATION		PHYSICAL		TOTAL POINTS	PLUS 200 BASE POINTS	÷4 EQUALS RATE	PRESENT RATE	INDUSTRY AVERAGE	FINAL APPROVED RATE
Millwright Helper	N	O	BAB	16	AB	18	BAB	8	AA	4	VHC	28	74	274	68½	.65	65½	61½
Millwright	BAB	18	HC	44	VHC	42	ABC	15	VHA	10	VHC	28	157	357	89¼	.90	.80	.90

Figure 1. With this sheet the job analyst goes to work

same relation was found to exist for physical effort, a 7½-cent differential; 30 points were then assigned to this characteristic.

Cooperation, in the estimation of the classification committee, was the least important in our industry, and 10 points were arbitrarily assigned. Initiative was thought more important, and 25 points were given to it. Training, which in some cases may involve years, was given a weight 50 per cent greater than supervision and physical requirements, or 45 points. To responsibility we assigned the remaining 60 points.

It is obvious that each of the six characteristics enters into jobs in different degrees or amounts. A paper machine tender, for example, has to organize his crew; he exercises a high degree of supervision. A beaterman on the other hand, who is required only to load paper into the beating machines, supervises no one. To express these differences, a scale of eight gradations was developed. Beginning at "none," the starting rate of a green operator's job, the scale reads "low," "below average," "above average," "high," "very high," and "exceptional."

Divide by Four

The instruction sheet shown in Figure 2 indicates that the point weights assigned to the six characteristics are spread over this scale in the same relative gradations. Dividing each of these point values by four indicates the differences in cents per hour.

At this point a refinement in the scale was introduced. It will happen that two jobs are rated as calling for average responsibility, but in looking at these two jobs side by side, it appears that there is a slight difference; one calls far a little more responsibility than the other, yet not enough to push it into the "above average" class, where 12 points or 3 cents would be added to it.

What may be called a horizontal refinement was added to the scale to provide for situations of this sort. *A*, *B*, and *C* divisions on each step of the scale permit a closer adjustment and comparison of jobs than would otherwise be possible. The "very high" scale in the *A* column, it will be noted, contains the maximum point value established for each of the six characteristics.

This is the bare skeleton. All jobs in each division are analyzed. A beginning is made by writing a brief description of the methods of operation, the equipment used, and the surroundings. This gives management a word picture of the job.

Each job is then examined for the degree to which each of the six characteristics is involved. A work sheet is used on which these characteristics appear as headings, with definitive questions or statements listed under each.

The analyst, using this work sheet, sits down with the foreman and fills in a description of each job under the appropriate heading and question. Then he takes this statement to the man on the job, reads it to him, explains what it is all about, and secures his agreement, by signature, that all features have been included.

Back to Committee

When the analyst has compiled work sheets for one division of the plant, the classification committee is ready to function again. This committee is composed of the personnel director, superintendent, departmental supervisor, and the job analyst.

The committee weighs one job with another, classifies them into groups of similar importance. Here is where the rating scale is used. It is a slow and painstaking process, but an important one. The "Classification and Rate Sheet" shown in Figure 1 is the result.

The rates given in the last four columns of this sheet are fictitious figures for illustrative purposes only. Obviously, the starting rate and the maximum rate may be anything desired or required. But whatever they may be, this plan of classifying jobs according to the degree to which the six characteristics enter all jobs does result in equitable rate differences.

AMERICAN BOX BOARD COMPANY

STANDARD INSTRUCTIONS _____
FOR **DATE** _____
GRADING OCCUPATIONS THROUGHOUT
MILLS AND WAREHOUSES

OCCUPATIONAL REQUIREMENTS	TOTAL WEIGHT POINTS
SUPERVISION	30
RESPONSIBILITY	60
TRAINING	45
INITIATIVE	25
COOPERATION	10
PHYSICAL REQUIREMENTS	30
	200 – TOTAL POINTS

GRADING OF EACH OCCUPATIONAL REQUIREMENT

GRADE	SUPERVISION			RESPONSIBILITY			TRAINING			INITIATIVE			COOPERATION			PHYSICAL		
	C	B	A	C	B	A	C	B	A	C	B	A	C	B	A	C	B	A
NONE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LOW	3	4	5	5	8	11	4	6	8	3	4	5	1	2	2	3	4	5
BELOW AVE.	7	8	9	13	16	19	10	12	14	7	8	9	3	3	3	7	8	9
AVERAGE	10	12	14	20	24	28	15	18	21	11	12	13	4	4	4	10	12	14
ABOVE AVE.	16	18	20	32	36	40	24	27	30	15	16	17	5	5	6	16	18	20
HIGH	22	24	26	44	48	52	33	36	39	19	20	21	7	7	8	22	24	26
VERY HIGH	28	30	32	56	60	64	42	45	48	23	25	27	9	10	10	28	30	32
EXCEPTIONAL	TO BE DESCRIBED																	

INDUSTRY RATES DATE

1	2	3	4	5	6	7	8	9	10	11	12
INDUSTRY HIGH				INDUSTRY LOW				INDUSTRY AVE.			

Figure 2. Classifications and values on this instruction sheet make it possible to evaluate fine shades of difference between job requirements

Are Men Over 40 Ruled Out?

Setting wage earners straight on this point is another job of industrial relations that may well be tackled by the concern that wants to build up morale. Here's how one company did it

EVERY wage earner over 40 knows of some other wage earner over 40 who has been laid off "for keeps" in favor of some younger man.

It bothers him. He wonders when his turn will come. He'd give his shirt to know how his own company stands on this important point.

Why not set him straight?

To the concern that wants to do this job, the technique is at hand. It is both simple and effective. And the cost is negligible.

We refer to the job as it was done earlier in the year by the Falk Corporation of Milwaukee. It's a job that can be easily duplicated.

They're Only Blueprints

The two exhibits are practically self-explanatory. They are nothing more than inexpensive 8x11 blueprints showing the actual results of studies made among the Corporation's employees.

The larger exhibit shows "how old we are," would indicate that the man over 40 hasn't a thing in the world to worry about. The smaller one shows "how long we have worked at the Falk Company," and again it is plain that the older man can have his job as long as he is able to handle it.

In the original version, by the way, this latter exhibit was embellished with little sketches showing employees at the various stages in life's long journey. But these sketches have been omitted here for the simple reason that they did not show up to good advantage in the 4 to 1 reduction required to include this illustration on the page.

For percentages of Falk employees in various age and service groups, see Tables I and II.

HOW LONG HAVE WE WORKED AT THE FALK COMPANY?

In which group do YOU belong?

Number of years worked at the Falk Company	Number of us who have worked for this length of time at the Falk Company
1 — 5	811
6 — 10	270
10 — 15	261
15 — 20	108
20 — 25	91
25 — 30	48
30 — 35	17
35 — 40	18

Some of the younger fellows would like to read a few stories about "The Old Days" from the veterans. How about it, you "Vets"?

"Doc" Dearth (Ed.)

TABLE I

Age Group	*Per Cent*
70-79	1.2
60-69	5 2
50-59	15.1
40-49	19.1
30-39	23.1
20-29	31.8
17-19	4 4

TABLE II

Years of Service	*Per Cent*
35-40	0.5
30-35	1.0
25-30	2.9
20-25	5 6
15-20	6.7
10-15	16.2
6-10	16.7
1-5	50 2

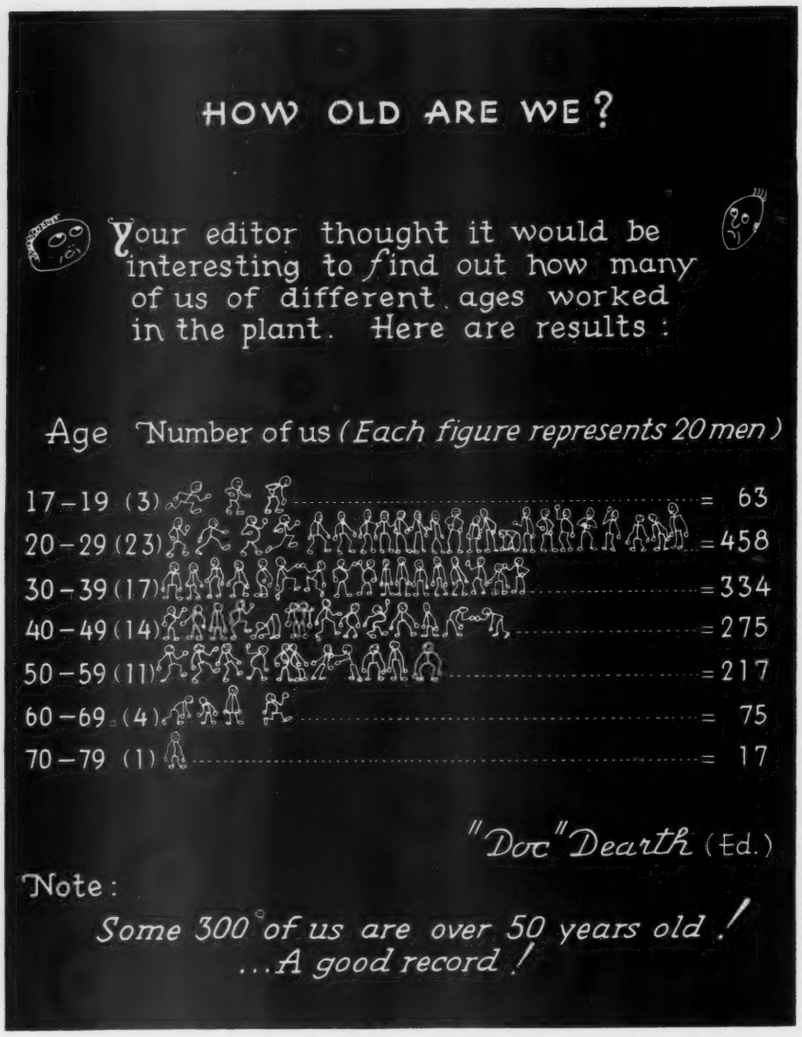

HOW OLD ARE WE?
Your editor thought it would be interesting to find out how many of us of different ages worked in the plant. Here are results:
Age Number of us (Each figure represents 20 men)
17-19 (3) = 63
20-29 (23) = 458
30-39 (17) = 334
40-49 (14) = 275
50-59 (11) = 217
60-69 (4) = 75
70-79 (1) = 17
"Doc" Dearth (Ed.)
Note:
Some 300 of us are over 50 years old!
...A good record!

FIGURE 1

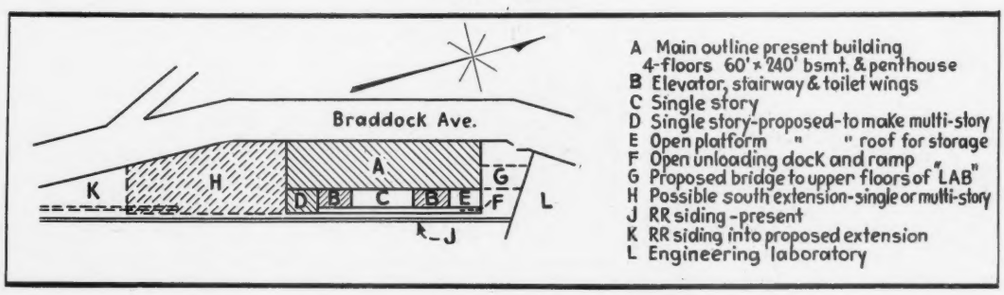
A Case in Small-Plant Layout

A. F. MURRAY

Manufacturing Engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Need for more space for one of its newer products led Westinghouse to set up a small self-contained plant within its huge East Pittsburgh Works. More than a year's successful operation makes it apparent that this is the practical answer to many of the problems of the concern with widely varying products

FIGURE 2



1. The Product

OUR COMPANY was recently faced with the problem of providing additional facilities for manufacturing small De-Ion circuit breakers and their assemblies in panelboards and domestic "load centers." The solution is a "plant within a plant" —the small De-Ion Breaker Department of the Switchgear Division at the East Pittsburgh Works.

Self-Contained Layout

East Pittsburgh was chosen as the site because engineering development of these devices requires availability of extensive laboratory facilities, and because of increasing use of these devices in combination with other products of divisions already located there. The nature and volume of the product justified a self-contained manufacuring layout.

Included in the problem are assemblies of metal stampings and plastic molded parts in many combinations in 1-, 2-, and 3-pole ratings from 15 to 100 amperes and 125 to 600 volts. An average month's production involves approximately 5,000,000 parts of 3,000 separate details. The existing line of standard thermal breakers consisted of 21 types with 104 styles; the new line under development will simplify this to 11 types with 52 styles. A new line of Nofuse load centers, 1 to 4 pole in a single unit, with 6 current ratings, gives 188 stock combinations.

Two new lines of panelboards were developed—one to use the new standard breakers for commercial and industrial lighting and power panels; the other, a line of De-Ion breaker panelboards.

A panelboard enclosure consists of a galvanized sheet box usually placed in the building wall before plastering, and a finished steel front or "trim" with hinged door and lock. The standard boxes were changed from single-piece to three-piece (wrapper sheet with separate ends) to facilitate manufacture, reduce stocks, and simplify field erection. In certain of the smaller boxes made in large quantities, the one-piece construction was retained.

The multiple-knockout arrangement for conduit connections to the boxes of lighting panels is standard for a large percentage of the items and is located in the box ends. The change to three-piece construction permitted these ends to be made in advance in large quantities in the general box shop of the metal-stamping department with standard production equipment that happened to be already available.

Lengths of boxes vary over a wide range according to the number of circuits. Many are 6 to 8 ft. long, and the average length is from 2 to 4 ft. In the three-piece design, it is only necessary to shear, to notch and pierce, fold the wrapper sheet, and assemble the stock ends to complete the average special order. For boxes with special knockouts and of varied width, the three-piece construction also simplifies fabrication.

2. The Site

IN SELECTING a site from the available floor space at East Pittsburgh the following requirements were set up:

1. All space must be in one block or several adjacent blocks.

2. Blocks of space must be of sufficient width and length to permit straight-line assembly rather than "string bean" layout.

3. Adequate facilities for both male and female employees must be available.

4. Floor capacity for storage and

FIGURE 3

FIGURE 4

fabricating portions of the plant must be adequate.

5. Railroad siding and truck-unloading facilities must be available and, of course, adequate.

6. Elevators must be adequate in dimension and capacity to handle all raw materials as well as electric truck deliveries.

7. Expansion by removal of other activities or building extensions must be possible.

The site selected was in parts of a four-story-and-basement building 60 by 240 ft. with a penthouse 30 by 200 (Figure 1).

Ready for the Future

This building has its own truck and freight car unloading platform. Elevator wells, stairways, and toilet rooms project from the main outline of the building. The building is located alongside of the main engineering laboratory building, which also houses switchgear engineering and sales.

Future expansion may be obtained by moving activities occupying parts of the basement and first floors, and the entire second floor, or by extending the building at the south end. Figure 2 shows these various possibilities for expansion.

The available space was distributed as follows:

Basement—storage of raw materials such as strip stock, bulky molded plastics, and certain fabricated parts that could not be stored alongside the assembly lines.

First floor—storage of large sheet, shearing of sheet, fabrication of panelboard boxes and trims.

Second floor—in use for other activities (to be released later when expansion of breaker activity becomes necessary).

Third floor—fabrication of metal stampings for breakers, breaker assembly, testing, packing.

Fourth floor—storage of finished breakers for panelboards, and panelboard details; parts fabrication and assembly of panelboards; assembly of multi-breaker load centers; assembly of breakers having special features; die repair shops.

Penthouse—sales engineering and accounting offices.

Fills the Bill

This site possessed the requirements for the self-contained plant within a plant. Naturally it is not 100 per cent self-contained because advantage has been taken of facilities existing in general works feeders and other East Pittsburgh divisions where surplus capacity existed or where quantities involved would not justify duplication.

3. Handling and Storage

BASEMENT STORAGE is used for strip and rod material and reel stock. Steel racks are located adjacent to the freight elevator running to the metal-stamping equipment on the third floor. There is an auxiliary chute for delivery of material from the receiving space on the first floor. No materials are piled directly on the basement floor. Only fabricated parts that are quite bulky or must be made in extremely large quantities for special reasons are stored here.

Large sheet steel is stored on the first floor adjacent to the unloading platform. A portion of this floor has no basement and permits high piling. The remainder has a capacity of 500 lb. per sq. ft. The area is served by a 6-ton single-hoist crane and a half-ton swinging jib. Both are electrically operated. Figure 3 shows a portion of this storage as well as the shears used for cutting sheet to width for the breaker-stamping presses on the third floor, and for cutting box and trim parts to size for the box and trim shop.

Some fabricated parts are stored in the basement or in enclosed storerooms. As far as possible they are carried in open storage alongside the production lines. Sectional shelving units are located between the rows of assembly benches. These units are 18 in. deep by 30 in. center spacing, 51 in. high, and do not interfere with light. They are set in single rows or back to back in double rows. Section combinations can be easily changed to meet new requirements.

Stored in Standard Trays

An enclosed storeroom is located on the fourth or panelboard and load-center assembly floor. This storeroom carries general hardware, stocks of panelboard details beyond a small floor stock, and finished breakers ready for assembly into panelboards and load centers. These breakers are not packed in cartons but stored in standard sheetmetal trays which are also used in handling the breakers through the constant-temperature test room.

Breakers supplied to other divisions or carried in general stock for shipment to customers are packed in cartons at the end of the assembly lines and placed on a roller conveyor which delivers them to a trailer loading station. Loaded trailers are pushed by hand to adjacent elevator,

FIGURE 5

unloaded by elevator operator on the first floor, and hauled by electric truck or tractor to the general East Pittsburgh warehouse.

Return trips of trailers bring cartons, also molded plastics and other feeder parts. Figure 4 shows a corner of the final assembly line with the 3-deck conveyor, packed cartons, and also trays of finished breakers, unpacked, being sent to fourth floor storage.

Special 12-tray trucks of the same general dimensions as a standard shelving section are provided for handling breaker trays and racks of the same design with wheels omitted are used for tray storage. When used as racks, they may be stacked two high to conserve space. The tray is fabricated from a single steel sheet in the box shop on the first floor. When desired, the tray may be stacked without use of special racks. Special tools were made for the hand opening and the stacking lip, but the other fabricating operations on the tray are done on standard corner dies and brake tools.

At present, panelboards and panelboard enclosures are packed and shipped in the general packing and shipping department, and trailers with special shelves are provided for transporting them there. Load centers are packed in cartons and shipped to warehouse in trailers in exactly the same manner as the finished breakers.

Figure 5, a general view of the straight-line load-center assembly on the fourth floor, shows loaded trailer units. It also shows the use of the standard container for both bench and bin purposes. Micarta angles are used as track to locate load-center boxes on assembly line. Electric screwdrivers are suspended from overhead trolley. Trailer trucks bring cartons and japanned steel boxes to the assembly line and deliver finished load centers in cartons to the general warehouse.

4. Box Shop Layout

FIGURE 6 shows the general layout of the box shop on the first floor. A general view of the sheet storage, shearing, and standard box fabrication on this floor is shown, you will recall, in Figure 3.

Two Speeds, No Whip

Included in the box shop equipment is a 10-ft. bending brake for box fabrication. It is provided with reversing motor-operated ram adjustment. The main motor also has reversing pushbutton control. For shorter boxes this is set up for two bending operations using one or two operators. This brake is a two-speed machine. Small boxes can be rapidly handled at 25 r.p.m., the larger and wider ones safely at 7 r.p.m., without "whip" of the sheet.

Much layout, drilling, and set-up of special dies are avoided by a universal turret punch which has a set of punches from $\frac{1}{8}$ to $\frac{5}{8}$ in. and quick-setting gage. The throat is 18 in. with no center post.

Special "knockouts" can be quickly made to layout in two punch presses. Each press has a die for three sizes and has floating punches. Removable "gags" block the float of the size to be used. Another press is located alongside for flattening knockouts. A fourth press provides for unusual sizes of knockouts or special operations.

A special shearing die is used for cutting door openings out of door trims. An opening of any size can be cut by adjusting depth or removing blades. Permanent scales and adjustable stops facilitate quick set-

ting. The piece cut out is trimmed and used to make the door.

This is the first operation on the door and trim after shearing the sheet to size. After this operation, door and trim pass through a series of small presses permanently set up for piercing hinge clearance, mounting holes, and lock clearance. Moldings and hinges are spot-welded in a 60-kva. spot welder with electronic control, and the assembled door and trim is then metal-finished, cleaned, and painted.

5. Breaker Manufacture

MANUFACTURE of the breaker units occupies the entire third floor. Except for plastic molding, automatic screw machine parts, plating, and heat treating, all fabrication is performed on this floor, including sub-assemblies, main unit assembly, test and calibration, final assembly, and packing in cartons.

Raising the Roof

It has not been found possible to include plating and heat treating without providing added space by raising the roof of a single- story section of the building occupying the corner between the south elevator and stairway projection and the south end wall. Adequate plating and heat-treating facilities are available in the general feeder division, and this part of the layout plan has been held over for future consideration. Plastic moldings and automatic screw machine parts are inherently feeder division parts, and their future inclusion in the layout of the "plant within a plant" is not contemplated.

The fact that new designs were being developed and put in production while existing designs were in manufacture, made it necessary to make the layout extremely flexible. A unique system of standard bench units and plug-in circuits was developed which has proved its worth on many occasions and has been given the nickname of the "india rubber" layout.

The fabricating section occupies the first four bays of the third floor at the south end of the building. Figure 7 shows the general arrangement. Material sheared to width on the first floor, and strip and reel materials from basement storage are brought up in the elevator and placed in stock racks, or taken directly to the blanking presses. Scrap is loaded into large containers fitting standard trailers and sent to baling presses in another part of the plant.

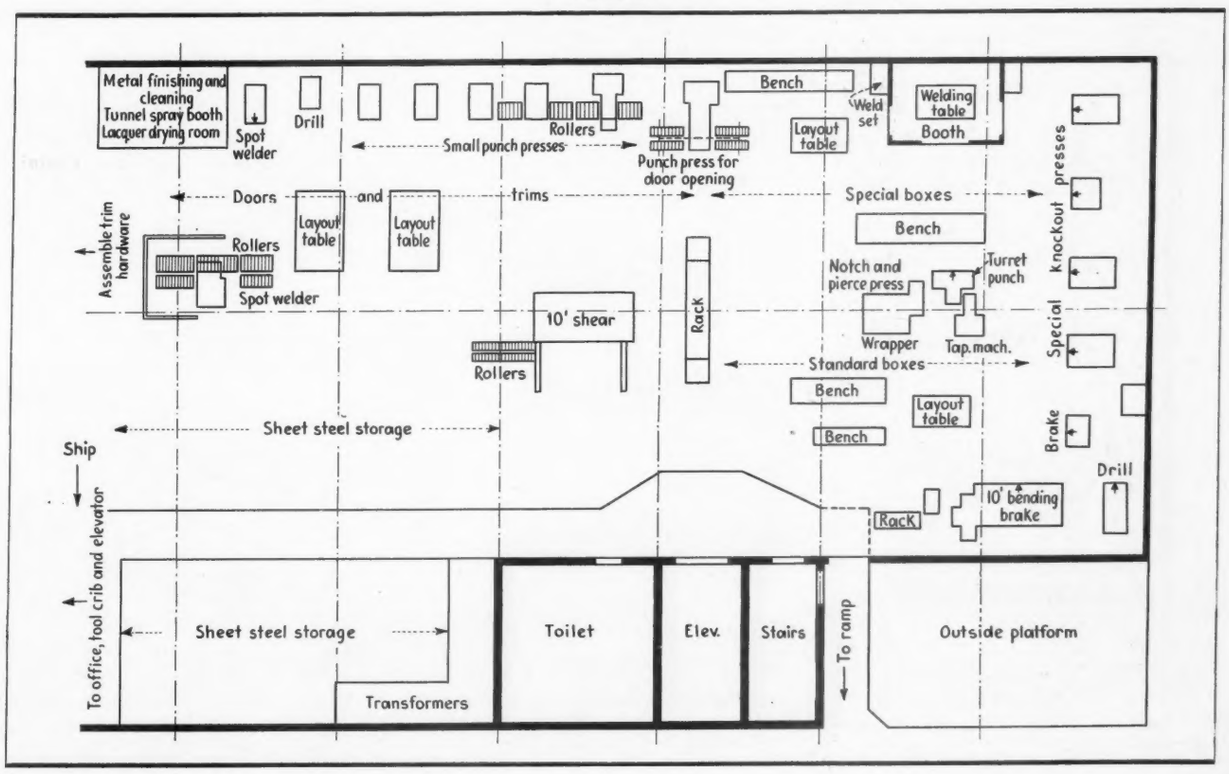
This section is provided with 25- and 50-ton dieing machines with double-roller feeds and scrap cutters, and inclinable presses of from 10- to 56-ton capacity. All are operated by d.c. variable-speed motors with pushbutton control. Three sizes of roll straighteners and gripslide feeds are provided for use with reel stock. Extra face plates are provided for the grip-feed crank disk so that each size may be applied to several press sizes according to the tonnage requirement of the job.

Figure 8 shows a terminal clip being made from a reel of copper strap in an inclinable press equipped with automatic-grip slide feed and stock straightener. Roller-feed and hand-feed inclinable presses may also be seen in the rear.

Home Made, Because—

This photograph shows an adjustable stock support consisting of a steel trough made of ⅛-in. sheet steel and a stand adjustable both for height of press and for vertical

FIGURE 6



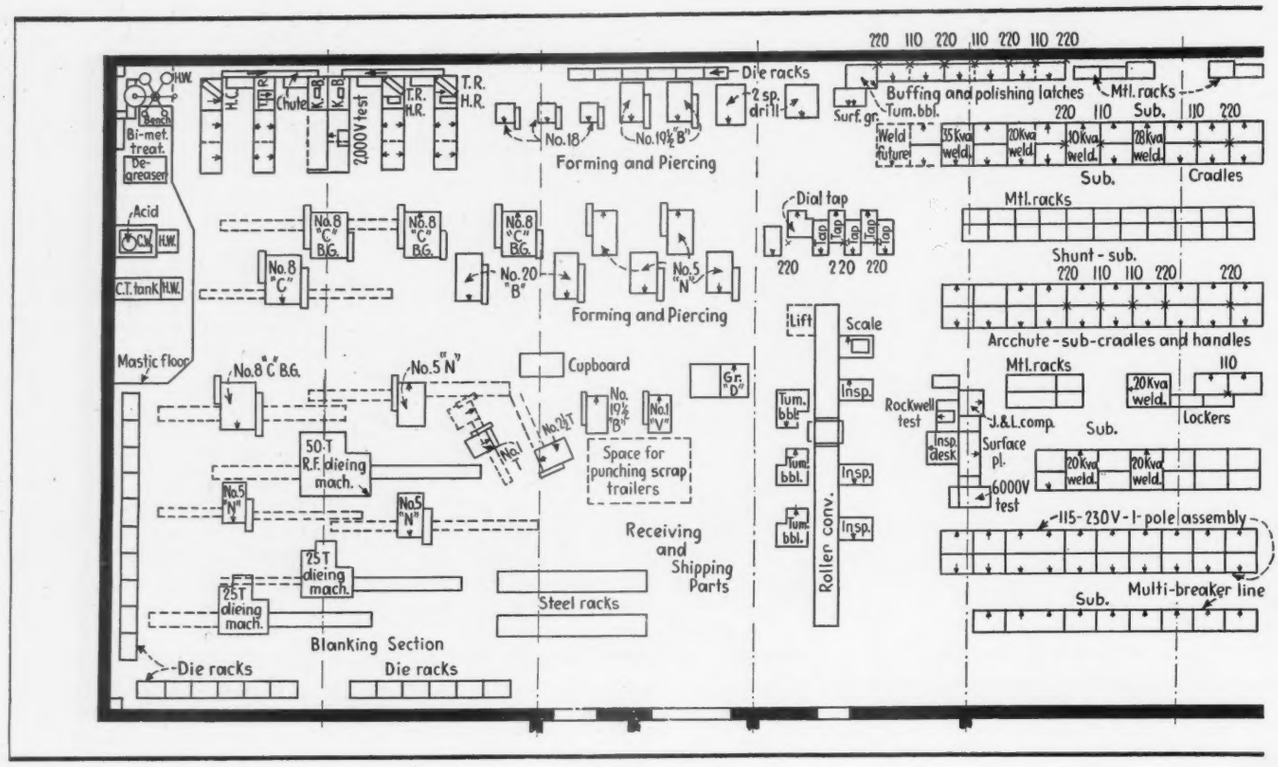


FIGURE 7

and inclined press operation. Both trough support and elevating rod may be clamped firmly in any position by lever-operated cam clamps. This device was designed and made in the shop as nothing suitable was available on the market.

Some of the larger presses in the piercing and bending section are backgeared to give a slow speed for drawing and for sharp corner bending. A number are equipped with cam-actuated die slides which withdraw the die from under the ram for increased safety in loading. All are provided with two-hand safety releases.

Several two-spindle drill presses, a multiple-spindle dial-feed tapper, a number of single-spindle high-speed tappers, and several barrels for tumbling burrs from blanks complete the fabricating section on the third floor of the plant.

Brains of the Breaker

In the southwest corner of this section is located a small treating and cleaning department principally for bi-metal thermal elements and braided shunts. Space in this corner, which had been reserved for additional punch presses, is now occupied by the bi-metal and latch assembly. Increased production requirements of the subassembly group and the necessity of keeping punching, treating, and assembly of these parts under close control as they are the heart, or rather the brains, of the device, caused this group to be relocated here. The "india rubber" layout permitted this to be done with practically no loss of production hours and at something that very closely approximates the lowest possible manufacturing cost.

6. Subassemblies

THE PRINCIPAL subassemblies are braided copper shunts and terminals, bi-metals and braided copper shunts, bi-metals and terminals, bi-metals and trip latches, plastic-molded handles and handle arms, plastic-molded handles and handle springs, cradles and bushings, cradles and latches, and arc chutes.

Figure 9 shows several electric spot welders used for welding, not brazing, braided copper shunts consisting of 1,176 strands of 0.002 diameter copper wire or 942 strands of 0.003 wire to copper, silicon bronze, and chromium-copper terminals without use of flux.

Spark screens with adjustable shatter-proof glass are used, but the screen was raised in the photograph to show more of the operation.

Seven spot welders of from 10- to 35-kva. rating are in use in the subassembly group. Some have electronic timers. Some have mechanical timers. These machines do direct welding of copper to copper, copper and silicon bronze to bi-metals of various analyses containing a high percentage of nickel, and steel to steel. They are also used for electric brazing of silver graphite and molybdenum silver contacts to copper and silicon bronze terminals using sheet or powdered brazing material and flux between carbon tips. For some of the combinations, special-alloy or rare-metal tips were developed and are being used.

The Anvil Slides

Figure 10 shows two interesting operations on the multi-breaker handle assembly. In front, a specially formed music-wire spring is being tubular riveted to the molded handle. The springs are stored in special grooved boards to prevent tangling. Board slides in an angle-iron track for easy reach as do the boxes of molded handles at the left of the

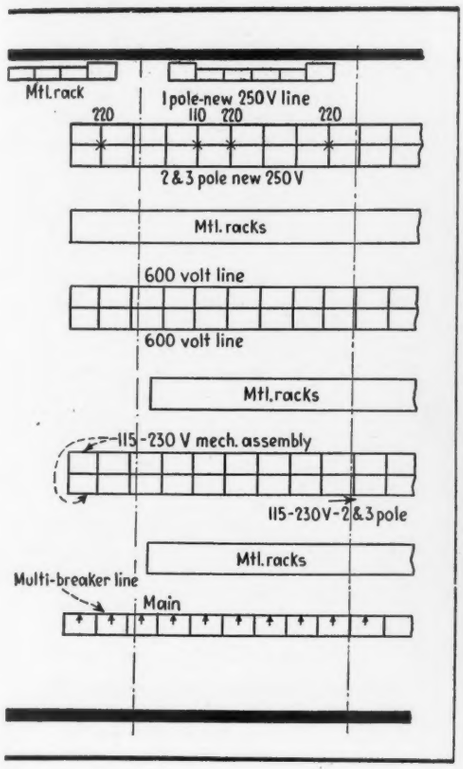


FIGURE 9

operator. The anvil of the riveting machine, instead of being fixed as usual, is mounted on a moving slide to remove operator's hands from under machine head while loading.

In the photograph the girl has placed the spring in position, moved right hand to slide, is placing molded handle on anvil with left hand, preparatory to moving slide under head with right hand. Head guard is low and will not permit work to be shoved under it until hand is removed from molded handle. Anvil spring ejects finished piece into a chute at left of machine to box shown in rear.

The girl in the background is marking the ampere rating on the black molded handle in white intaglio. An electric soldering iron with engraved-steel marking insert and rheostat for heat control is mounted on a portable drill stand with small foot-operated air cylinder attached. A special paper marking tape is placed over the molded part to be marked and the hot iron depresses the figures and fills the depression with white marking at one operation. This device is also provided with drop delivery. In the background are the walls of the air-conditioned test room.

FIGURE 8

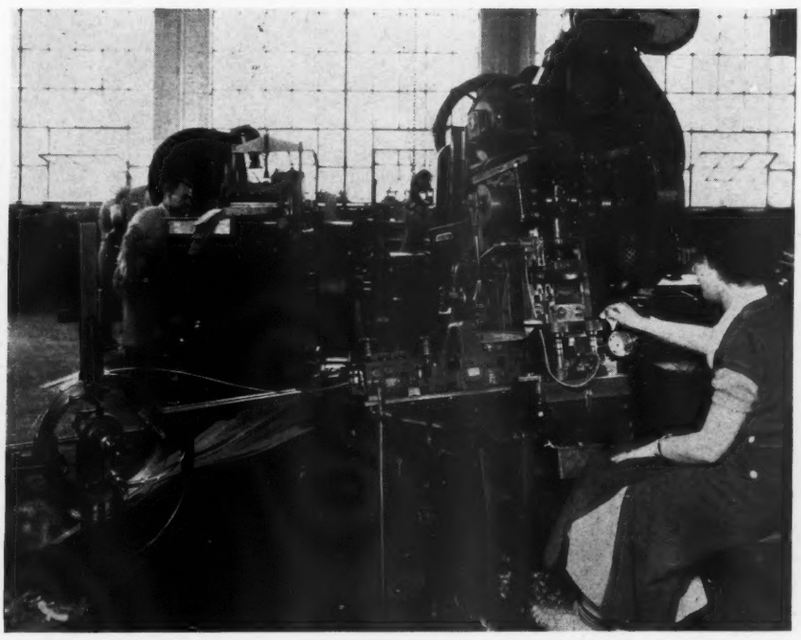


Figure 11 shows handle and handle-arm assembly, and cradle and bushing assembly. Two lines of sectional bench are placed back to back. Each section is 3 ft. long by 2 ft. wide, and has a separate motor-driven machine mounted on it, and a BX armored cable for connecting to a floor plug. Provision is made for four plug outlets, 3-phase, 60-cycle, 220 volts every 6 ft., and 110 volts single-phase in the intermediate 3-ft. positions, making them also on 6-ft. spacing.

Conduits Under the Floor

Outlet sockets are brought up where required from conduit lines beneath floor at bench center lines with provision for tapping every 3 ft. Galvanized metal covers clamping to outlet socket boxes and BX clamp of socket plug act as hold-in for plug and ground for machine.

Bench tops are of phenolic-var-

FIGURE 10

nished maple, and are held to plus nothing and minus 1/16 in. in both length and width dimensions, so that one machine may be changed for another or moved by simply loosening bench-leg lag screws, removing galvanized plug cover, and pulling out connection plug. Standard steel bench legs are used and cross braced when necessary.

Chicken Feeders

Figure 12 shows a toggle-type pneumatic riveter for riveting moving contact to contact spring and bracket assembly on new 250-volt breakers. This device is foot-valve operated, and special attention is called to the safety loading slide. The operator's left hand is on the slide handle, her right hand on the locating latch, which must be released to move the slide from either in or out position. A steel guard covers the plunger and just allows the slide to clear.

Figure 13 shows a percussion-hammer spinning riveter assembling

FIGURE 11

FIGURE 12

FIGURE 13

the new 250-volt single-pole latch with insulation and cradle. Rivets are formed as part of the cradle stamping. The latch and insulation pieces are quite small, and parlor match boxes mounted on a bent sheet-steel bracket make good "chicken feeders" for locating parts. Standard container similarly mounted holds cradle stampings.

7. General Assembly

FIGURES 14 and 15 show the general layout of the assembly section of this floor. This consists of three double lines and one single line of standard bench sections 2 ft. wide by 3, 6, or 9 ft. long, arranged with standard bin sections between.

Assembly machines are all mounted on individual 3-ft. benches as described in Figure 11. Cord and plug power lines are provided under these benches. On column 7 (see Figure 15) is a panelboard containing six 110-volt and six 220-volt De-Ion breakers which permit sectionalized control and protection of the plug-in circuits.

A comparison with a photograph taken on the same spot six months earlier would show that a row of storage racks had been replaced by an additional assembly line for single-pole 230-volt breakers. This is mentioned to illustrate the flexibility of the sectional bin and bench system. The entire change was made the day it was decided on, and breakers were being assembled the next day on the new line.

The general scheme in each of these assembly lines is similar. A series of small riveting machines for assembling the details of the mechanism start the line. Next comes assembly of the mechanism and the arc chutes into the molded base, mechanical adjustment, checking of contact resistance and contact spring pressure, insulation test, and mechanical inspection.

Breakers are then placed in the standard trays, which are loaded on trucks. The truck load of trays is then wheeled into the constant-temperature test and calibrating room. Here breakers are held until they have become normalized to the temperature of the test room before being worked on. This waiting period caused selection of trucks instead of conveyors from assembly to test.

All breakers are set and calibrated in an enclosed room which is maintained at 75 deg. F. plus or minus one-half degree. It is located on the third floor in proper layout sequence. A 10-ft. space between its walls and the nearest outer wall reduces the size of temperature control equipment necessary.

Entrance and exit are from one refrigerator-type door on the "before test" side and one on the "after test" side. Walls are 13/16 beaded wood sheathing for the first 4 ft. from the floor, between 2 by 4 studs. Intermediate space is filled with rock wool. A 30-in. high double glass belt with 1-in. air space between the two rows of panes is next, and from top of glass to ceiling the studding is covered on both sides with ½-in. Celotex with air space between. The air-conditioning cooler unit is mounted from the ceiling. A 4-ton electrically driven compressor to supply the necessary refrigeration is located conveniently on the floor above.

Figure 16 shows one of seven 4-position test tables on which the breaker units are checked for correct tripping time under full ampere rating after they have reached normal test room temperature and have been mechanically set.

If the breaker does not come within the limits at the first check, it is readjusted and allowed to cool to room temperature again before making a second check. The constant-

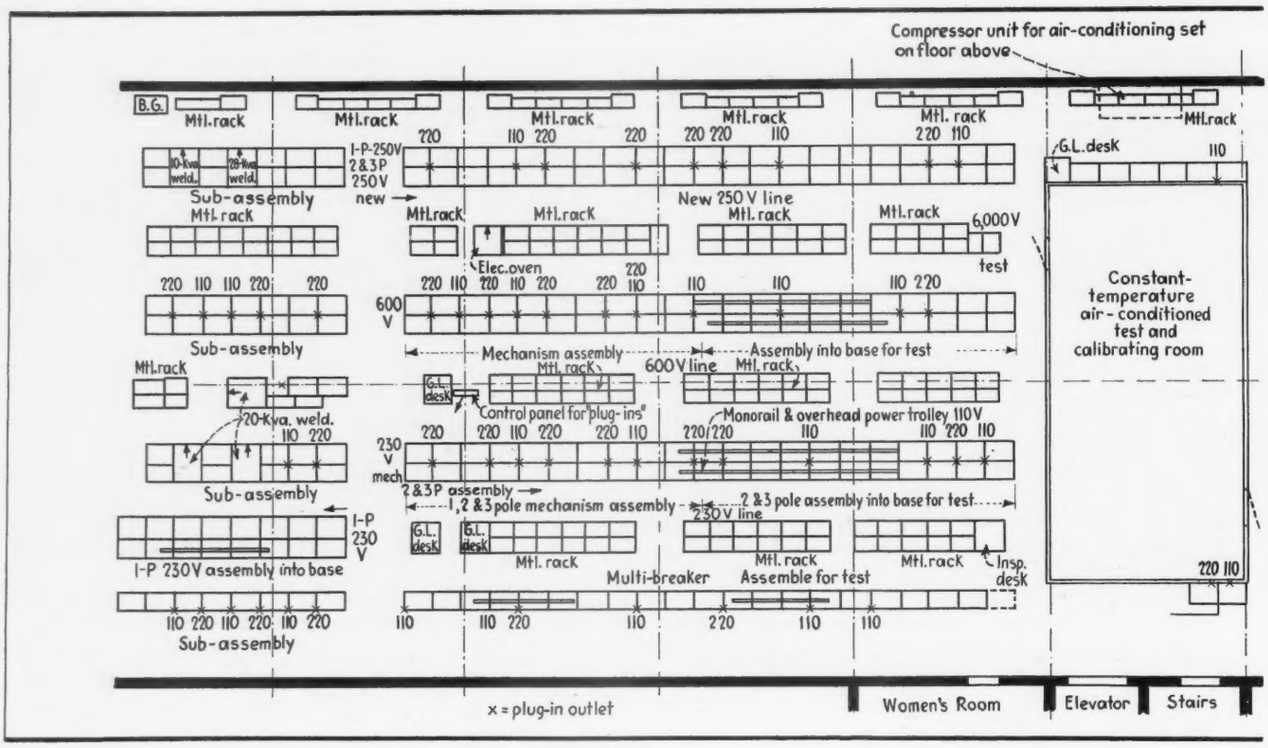


FIGURE 14

temperature test room assures uniform field performance regardless of season of manufacture. Constant-temperature setting and test are essential to provide standard movement of the bi-metal thermal element to trip the breaker under load within the proper limit.

The test table shown in Figure 16 is 5 ft. long by 38 in. wide and has four separate power circuits. Each is independently controlled by a De-Ion circuit breaker shown near the bottom of the sloping panel. Voltage and amperage are controlled by an auto transformer for each circuit, two of which may be seen mounted below the table top at the operator's left. The other two are similarly mounted at the right.

In the center of the sloping panel are multi-scale ammeters each with a tap changing switch to the current transformer mounted beneath it. On

FIGURE 15

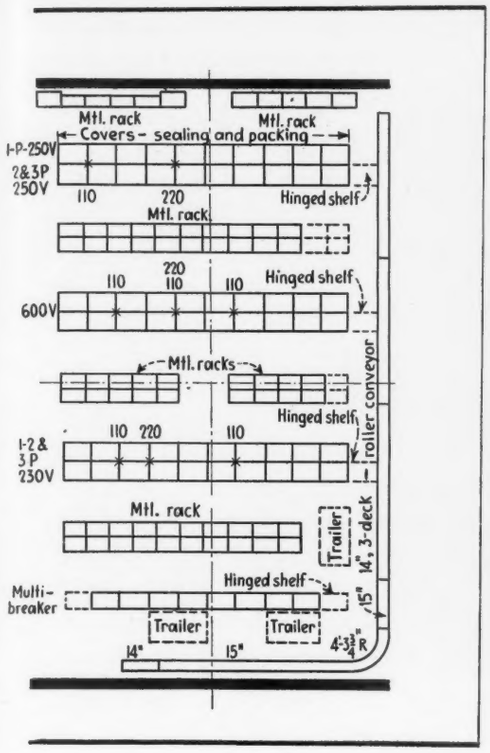


FIGURE 16

the top of the panel are four direct-reading electric timers. The operator is shown throwing a lever which applies current to four circuits of a multi-breaker at one time and starts the electric timers in operation.

For other styles of breakers, different fixtures are used, and separate breakers are tested in each of the four circuits. In order to insure that test-room current and voltage supply will not be disturbed by variations of load in the manufacturing section, a separate circuit with its own voltage regulator and transformer is provided directly from the 2,200-volt main power line.

Breakers that have been tested and calibrated are delivered to the "assembly after test" section in the trays and trucks previously described. Covers are assembled and sealed. Breakers are labeled and packed in storage trays or shipping cartons.

Arrangement of benches, storage racks, and roller conveyor is shown at the right in Figure 14. Figure 4 referred to in discussing storage and handling facilities shows the end of this assembly line with packing of breakers shipped to warehouse and trays of breakers being sent to storage unpacked for panelboard and load-center assembly. Roller conveyor delivers product of four assembly lines to single shipping point in aisle at side of building adjacent to elevator, for loading in trailers or tray trucks.

8. Fourth Floor Layout

PANELBOARD, load-center, and special breaker assemblies are located on the fourth floor.

Panelboard assembly (Figure 17) is an essentially different type of work from breaker assembly. This work occupies the north end and central portions of the floor. It is seldom that two panel orders have the same combinations of breakers and connections. Short delivery dates are essential.

Stocks of standard breakers and connection details are carried in the enclosed storeroom at the rear of Figure 17. Here also are carried standard copper bus bar sections drilled and tapped in 10-ft. lengths, special rolled steel panel-frame sections, and back panel plates also in lengths.

Cutting to Length

In front of the storeroom but in rear of assembly benches are a group of punch presses, saws, and drilling and tapping machines for fabricating these long lengths and cutting them to length as required for customers' orders. Tubular riveting machines and a spray booth for painting assembled frames are also located here.

To the left of the assembly benches is a rack for a floor stock of principal details and popular sizes.

All panelboards are assembled from engineering information prepared directly from the customer's order. The assembler must lay out and cut bus bars, frame, and panel plate to engineering layout. Each panel order is assembled complete on one of the rows of assembly benches and placed on the roller conveyor in the foreground for final inspection and delivery to shipping trailer.

The bench in the foreground of Figure 17 is used for assembly of 16-circuit load centers of the multi-breaker type. These are packed in cartons before delivery to shipping department and are assembled progressively, starting from one corner of bench and passing up one side and down the other.

Eight-circuit load centers are assembled in a straight-line layout at the southeast end of the fourth floor. Japanned load-center boxes fabricated in the central metal-stamping feeder section of the East Pittsburgh Works are delivered to the line in trailers which later take the finished load centers to the warehouse. Boxes are

FIGURE 17

slid from operator to operator on micarta angles fastened to bench to prevent marring of finish. Electric screwdrivers and nut setters are suspended from a trolley track above the line and hang free on a spring mounting when not in use.

The Final Check

Figure 18 shows this line from the packing end. The second operator from the left is placing cover on breaker. An angle-locating device fitting over corner of cover is attached to the electric screwdriver frame. Before placing covers on breaker, current is applied to each circuit to be sure that nothing has happened to breaker since test that will prevent its functioning in service. The breakers are brought to the line in the standard breaker trays and trucks from the storeroom at the other end of the department.

With six current ratings and single- and two-pole combinations and from six to eight circuits in each load-center box, the number of styles carried in stock is 102—and many other combinations are possible.

For Special Breakers

A line of benches partly shown along the windows in Figure 18 is used for building special parts and assembly of breakers similar to the regular line of small De-Ion breakers but which have special features such as magnetic instead of, or in addition to, thermal trip. This covers only the operations up to setting and calibrating. They are sent to the constant-temperature room on the third floor for this operation and remain on the third floor for operations that follow calibration.

Located in the southeast corner of the fourth floor is the die maintenance section. This is directly above the metal-stamping presses on the third floor. It is equipped with lathes, grinders, drills, and milling machines for this work, and in addition has racks for the used dies for which there is not sufficient rack space on the press-room floor. Approximately 800 dies must be sharpened and kept in good repair. New dies are made in the main switchgear tool department. This is a good illustration of a point already made—that in some cases it is more economical to use existing facilities than it would be to set up a special section.

FIGURE 18

70° Cool Inside!

Temperature and humidity are always just right in Buick's air-conditioned engineering building. Result: No more summer slump in efficiency or output, and everybody's happy

FRANK ELWELL
Works Engineer
Buick Motor Company

DURING the extremely hot summer of 1936, efficiency in the engineering and drafting rooms was reduced almost to zero, and sick leaves were frequent. At that period of the year these departments should be going at high speed in preparation for the introduction of new models in the fall. To improve working conditions, consolidate related engineering departments and, at the same time, provide much-needed additional space, a three-story building was constructed. In it was installed the latest in air-conditioning equipment.

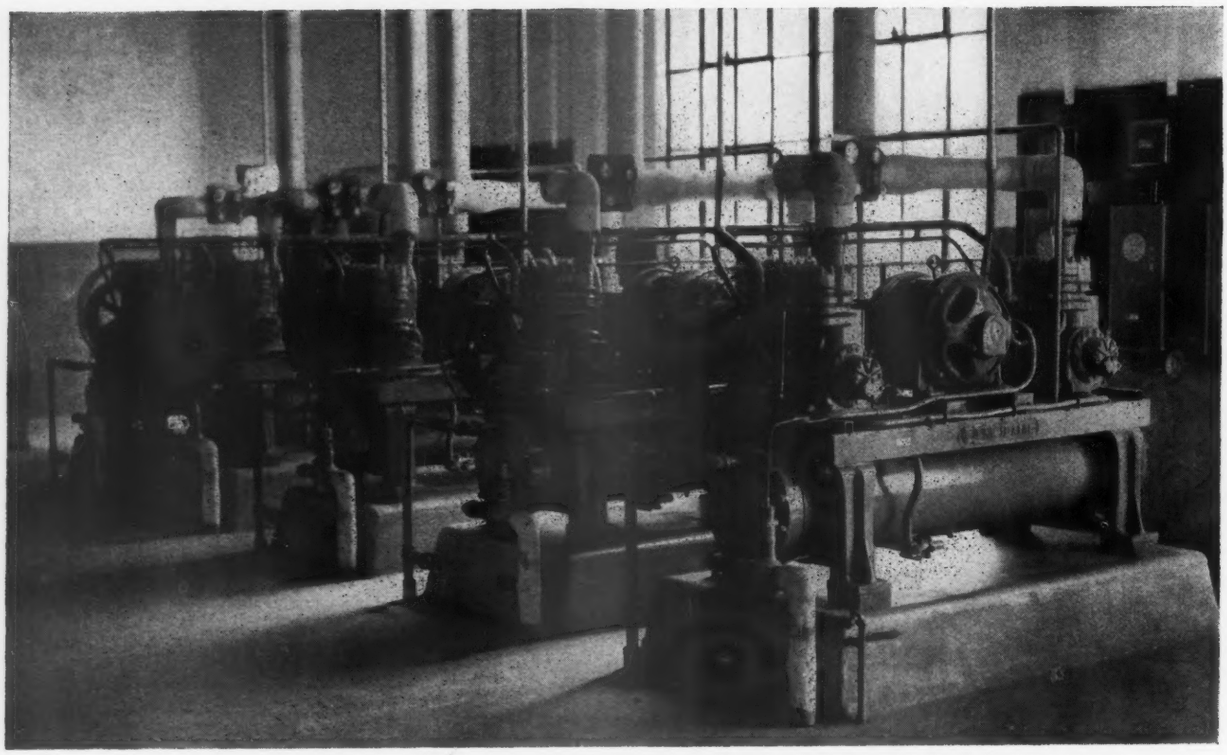
The past summer, although not a markedly bad one from the standpoint of high temperatures, amply demonstrated the value of this feature of the building. Seven air changes an hour, of the correct temperature and humidity, provided very pleasant working conditions. No variation in the output of drawings was noticeable, even on the hottest days. Draftsmen did not find it necessary to remove drawings, tracings, and estimate sheets from sticky, perspiring arms. Sick leave requests disappeared completely. However, a tendency of salesmen to prolong interviews was distinctly noticeable.

The master mechanic's and the works engineering departments, including the drafting rooms, occupy the third floor, which contains about 46,000 sq.ft. of space. This floor is served by a separate refrigeration and heating unit. The building lobby, first floor, and the purchasing and metallurgical departments on the second floor likewise have a separate system. In the case of these two units, 22 per cent of the delivered air is drawn from the outside.

The hospital is served by a third air-conditioning system, with no recirculation of the air.

For cooling the third floor there are five compressors, each of 25

This view of the general office section on the third floor shows the kind of ceiling insulation used and the outlets for conditioned air



The five 25-ton compressors which provide refrigeration for the third floor

tons capacity. Cooling in five steps is thus provided, each compressor cutting in and out automatically, and supplying a certain section of the cooling coils. Thermostatic control placed in a common return duct leading into the ventilation unit operates solenoid valves which regulate operation of compressors.

No Noise

Air is supplied at the rate of 62,000 c.f.m. It is drawn from the floor and passed through spun glass filters, over the cooling coils, and finally over the re-heating coils, which are fed by exhaust steam from the hammer shop. The filters and cooling and heating coils are located in a housing measuring about 14 x 27 ft. placed between the inlet and outlet ducts.

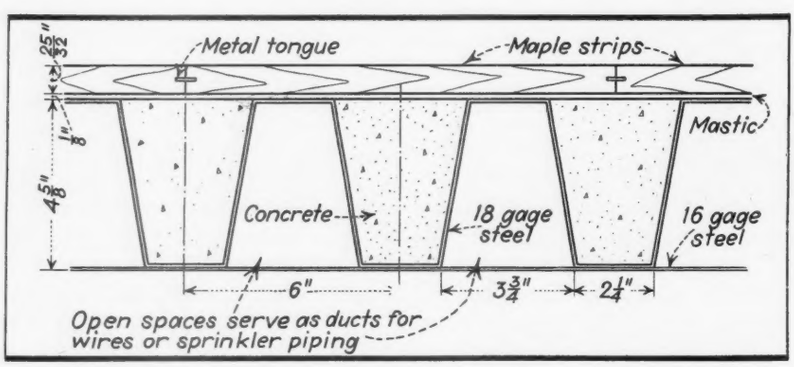
A very noticeable feature of this installation is the absence of air noises. This condition has been secured by the use of oversized ducts; the air velocity is not more than 1,000 c.f.m. in any duct.

Within limits, any desired temperature or relative humidity can be provided. However, it is considered that a 12- to 15-deg. difference from the outside air conditions is suitable for office and drafting room work, because under these conditions no shock is experienced upon going outside the building.

Automatic control of the air conditioning equipment is provided, but is not relied upon exclusively. The operator checks four times daily the outside temperature against the temperature and humidity of the return air from conditioned spaces and, if necessary, makes adjustments to the thermostat and hydrostat located in the delivery air duct, which automatically regulate the number of compressors to be cut in or out in order to maintain a predetermined differential between outside and inside temperatures. Thermostats on the reheating coils are adjusted to reduce the grains of moisture in the air to the desired relative humidity. As in the case of the compressors, the reheating coils are divided, in this instance into two sections, to make the operation of the system more flexible.

When the outside temperature is below 60 deg. F. the refrigerating machines are manually cut off by a summer-winter switch and cooling is provided when necessary by opening dampers in the incoming duct, so that outside air is drawn in and the return air is shunted to the outside. Air taken from the outside at 60 deg. or below is then passed through glass filters and drawn over the heating coils to give it the correct temperature for delivery to the third floor departments.

In the in-between seasons in fall and spring the compressors cut in and out and the dampers that regu-



Floors are constructed of corrugated steel, with a wood (maple) covering laid on mastic. Rows of flooring are joined by metal tongues inserted in the ends of the strips

late the amount of outside air taken in, open and close, depending upon whether the outside air goes below or above 60 deg. All these actions are controlled by appropriate setting of the hydrostat and thermostat on the incoming air duct.

One would naturally expect that insulation would be a major item in air conditioning such a large space, and so it is. In line with modern building construction, the side walls are mostly of glass. In making the calculations of heat losses when designing the system, it was found that venetian blinds would reduce the amount of refrigeration capacity required by some 12 tons.

The ceilings were insulated by gluing ½-in., wood-composition, wallboard to the steel plate forming the ceiling. Although the primary aim was to provide adequate insulation, it was found that this material is a very effective noise reducer. Despite the fact that 400 people work on this floor it is about as quiet as a private office.

Floors also were designed to reduce heat losses materially. As shown in one of the illustrations the steel floor is of cellular construction, produced by welding a corrugated plate to a flat plate, forming cells approximately 4½ in. deep by 3 in. wide. In the construction of this building the flat side was placed down, forming a smooth ceiling for the floor below, while the upper or corrugated side was brought to a smooth, level surface by filling the open cells with concrete. Thus, in cross-section there are alternate closed cells, or air spaces, and cells filled with concrete.

When Wiring Is Changed

This design not only develops the maximum efficiency of the steel, but it provides a multiplicity of potential conduits or raceways for the installation of electrical wiring that can be used whenever a change in layout calls for a change in wiring. This subfloor is covered with thick coating of a bituminous composition which does not harden. One-foot sections of maple flooring were placed over this base.

These sections of flooring, which were laid in parallel rows, are not fastened to the underlying floor members. Instead, the end of each piece of flooring is grooved and a metal tongue joins each row to the next. No nails were used. Expansion joints of cork were provided at the walls and around columns. The advantage of this construction is that the floor can expand and contract, or move slightly, without forming humps or destroying the alignment.

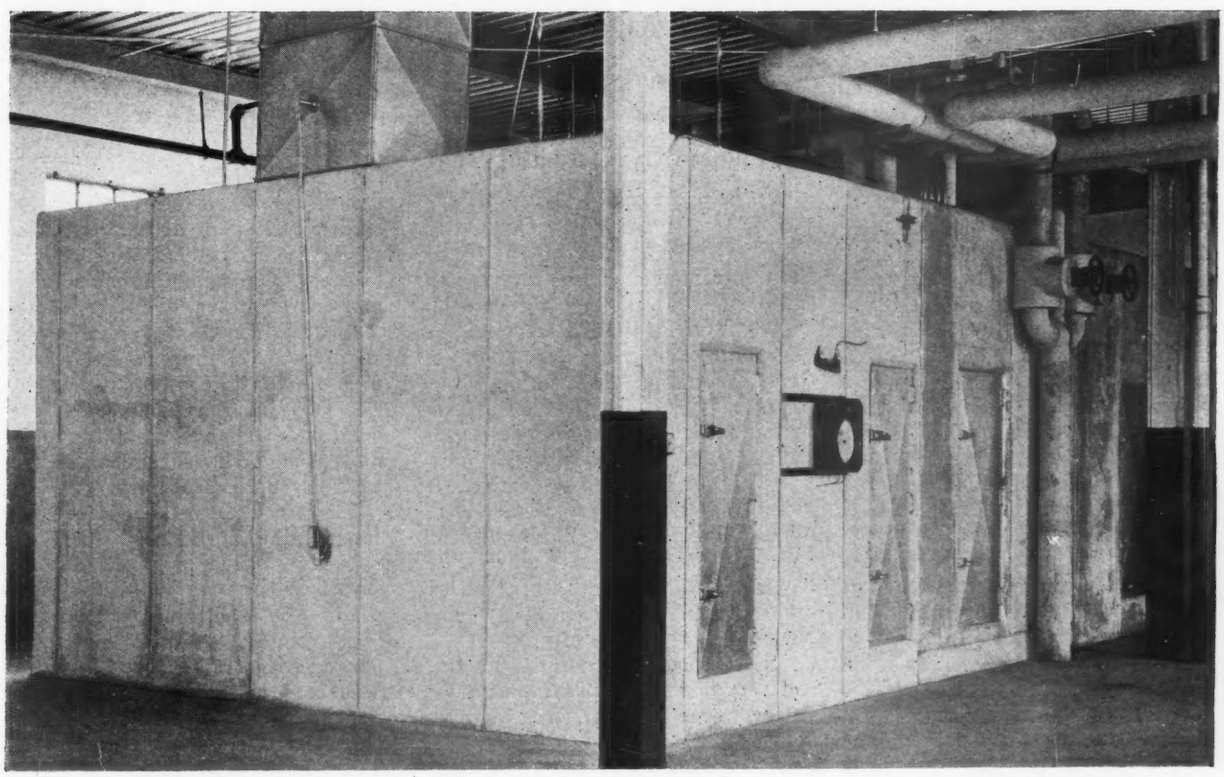
As mentioned above, the same corrugated steel construction was used for the roof and the insulating wallboard was glued to the steel plate attached to the corrugated section.

The open corrugations or cells in the floor serve as ducts for carrying telephone and buzzer cables, whereas those in the ceiling carry the sprinkler pipes and feeders for the lighting system.

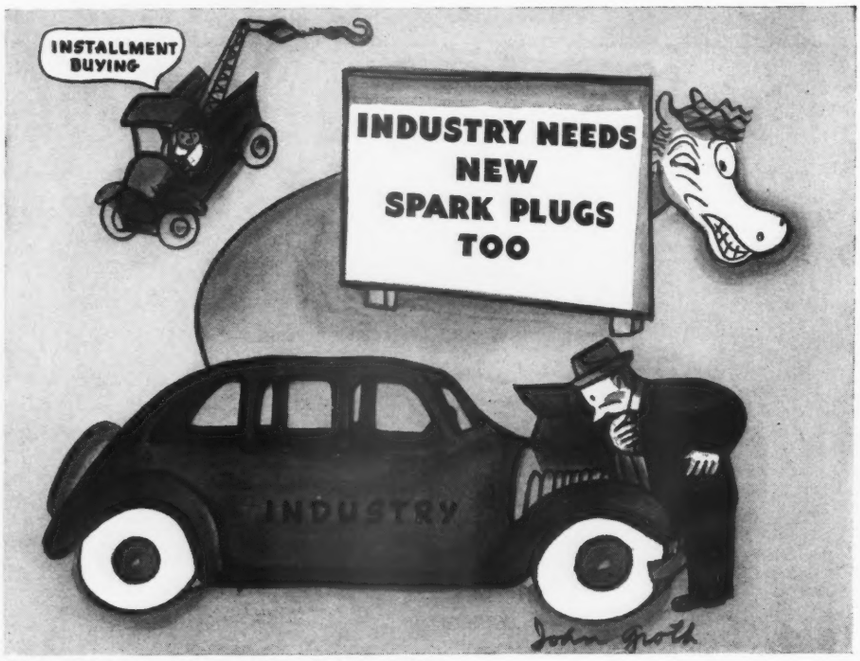
Heat losses through the roof are reduced by a 2-in. covering of insulating material similar to that on the ceiling of the room. The space between the ceiling and roof deck is occupied by the duct system which takes air to and from the air conditioning equipment.

This installation has now operated with complete satisfaction during the extremes of summer and winter temperatures. Comfortable working conditions can be maintained at all times, irrespective of the outside temperature and humidity. As a result normal efficiency and output of the engineers and other employees are possible in the heat of summer, when they are of vital importance in the introduction of new models.

Moreover, the building is so well insulated that these ideal working conditions can be provided at reasonable cost.



Here is the air conditioning coil chamber, located in the apparatus room in the penthouse. The instrument mounted between the two floors is the temperature and relative humidity recorder



With apologies to AC Spark Plug Division, G.M.C.

$500 Down—Three Years to Pay

Industry has taken to installment buying as a sensible way of finding outside money to finance the modernization of its plants and equipment

FREDERICK A. SMITH
President
Miller, Franklin & Company, Ltd.
New York

THE REVENUE ACT of 1938 in its present form has put a definite end to the hope that some surplus would be exempted from taxation and made available for much needed plant and machine replacement. Moreover, such consideration as other taxes and restrictions upon trade make the accumulation of even a moderate surplus extremely problematical for the bulk of the smaller manufacturers. Outside money must be found, therefore, for all the plant modernization made acutely necessary by seven years of neglect.

Let us take the situation as it is and consider what other methods of financing renewals, replacements, and expansion of plant there may be.

It is unnecessary to dwell upon the possibility of securing funds for the purpose through governmental agencies, as the Reconstruction Finance Corporation. In the first place, it is somewhat repugnant to the independent American way of doing business to apply to the government for aid, as though private industry were on relief. Our industrial structure is, or should be, dependent upon private initiative and private financing. When it is no longer able to do that, our entire system of enterprise, developed during 160 years of national prosperity, will have become extinct. It seems hardly necessary, therefore, to add "in the second place," which is that such federal loans can only be obtained under requirements that are unacceptable to independent going concerns.

So we come, finally, to the question of obtaining from private sources the funds necessary for the purposes under consideration. Let us be a little more specific as to what these purposes may be.

Most manufacturing concerns entered the depression going full throttle on orders far in excess of capacity, piled up during the boom days. At such times, the natural tendency is to use all available buildings and equipment to the limit. Replacement of machines, which is usually a matter of shutting down whole departments, is then rarely possible. The only judicious alternative is to build and equip new buildings, to be thrown into additional production immediately upon completion.

This was done in some cases—for instance, the can business, which had suddenly profited by repeal and an amazing advertising and selling campaign. The steel industry, too, went in for complete new mills for continuous and cold rolling.

Other fast-growing industries had no alternative but to build entirely new plants or sections of plants. There was rayon rapidly displacing silk and other fibers, tobacco in the process of doubling its sales of ci-

garettes, the formerly forbidden beverages, the many prepared foods, and a host of other consumer articles like electric refrigerators, domestic appliances, oil-burners, radios, and, of course, automobiles.

The plant enlargements and modernizations of these more spectacular industries, carried out before the Revenue Act of 1936 went into effect, obscured the fact that thousands of others, engaged in supplying the staple demands of the public, were doing little or no expanding or replacing.

Just how much machinery is obsolescent in the last-named class of plants is a matter of conjecture. Familiarity with the depreciation accounts of a great many plants would lead us to the conclusion that the figure might be as much as 60 per cent in dollar value of all their mechanical, electrical, chemical, and heat-treating equipment.

This represents a huge sum of money. According to the Census of Manufactures, there were, in 1929, 209,862 manufacturing plants in the United States. The total value of all plant and equipment has been estimated by reliable authority as $69,610,000,000, of which $41,805,000,000 represents machinery and other production equipment. Sixty per cent of the latter sum would be $25,083,000,000. This obsolescence is based upon an average life of 10 years for all equipment in all industries.

Bank borrowings, with a few exceptions, may help to a limited extent, where business expectations are good. But, as everyone knows, they are of the short-term variety.

Buying on Time

Meanwhile, there is already in existence a method of long-term financing of manufacturing equipment, which merits consideration in this connection. It is an outgrowth of the installment-buying system for consumer goods, which alone has made possible mass ownership of automobiles and domestic equipment from vacuum cleaners to homes.

Now the enormously strong automobile finance companies have accumulated so much capital that they have long sought new outlets for it. The most obvious and desirable outlet is the financing of such permanent investments as plant equipment. Some of the strongest companies in this field organized departments for that purpose some time ago.

They operate in this way: Instead of financing the *purchase* of new machinery by the purchaser over a period of years, they finance the *sale* by the vendor, who must make his own arrangements with his customer. This is a somewhat new conception of installment buying, but an eminently practical one.

It Can Be Arranged

A plant owner, let us say, has decided that he can cut his power costs by making his own power with diesel-electric units. He calls in the manufacturers of diesel engines, of generators and switchboards, and tells them what he wants. He also tells them that he must have terms of payment, extending over three, and in exceptional cases, five years. The engine and generator manufacturers may be in no position to extend such terms. But, they say, it can be arranged through certain finance companies if the purchaser and the vendor will agree to the required terms:

1. The financial statement of the buyer must meet the requirements of the finance company.

2. He must forego taking title to his purchases until paid for.

3. The vendor, who is really the other principal in the transaction with the finance company, must show that he is in satisfactory financial condition; this he has usually established in previous transactions.

4. The contract must be amortized monthly over the period of its life.

Although the equipment of private power plants bulks importantly in this class of financing, it is by no means limited to them. Almost any kind of manufacturing equipment may be acquired under the same arrangement. One of the leading finance companies publishes a list of 68 industries in which it has aided in the purchase of manufacturing equipment. It includes baking, bottling, canning, dairying, dyeing, ice cream, laundry, machine shop, printing, refrigeration, rolling-mill, sawmill, textile, and woodworking machinery.

Nor is the financing limited to the machinery alone. It is quite possible to finance all the equipment for entire production departments, including motors, transmission, and conveyors. Buildings are not financed by this method, though certain classes of building equipment as air conditioning, cranes, pumps, and sprinkler systems are so financed. It should be understood, however, that such installation expenses as the concrete foundations and the piping fastened to the building, for a diesel engine, as an example, are not recoverable by the vendor and hence are not included in the financing contract.

At this point the question of terms naturally arises in the interested reader's mind. The period over which the purchase is to be financed, depends partly upon the nature of the equipment and partly upon the credit record of its manufacturer and his client. It ranges ordinarily up to 36, and in exceptional cases, to 60 months. Obviously, if a piece of equipment will wear out or become obsolete in 24 months, it cannot be financed for more than that period.

The charges are 5 to 6 per cent upon the total amount of the loan for 12 months credit, 10 to 12 for 24 months, 15 to 18 for 36 months. In other words, the charges are fixed for the period of the contract, which, however, must be amortized monthly.

It must be understood that we hold no brief for any particular form of financing the purchase of the vast amount of obsolescent equipment. Still, in the absence of other long-term methods, the one described appears to be sound business practice.

Watered Stock

The equipment itself is the major security, not a real estate mortgage or a bond issue secured by the real estate nor yet an issue of additional company stock, which many have thought to be the only way of raising funds for plant replacement, renewal, or enlargement.

The last would be a particularly vicious way to meet the hampering effect of the surtax upon plant modernization. If carried to its logical conclusion over a period of years, it would ultimately mean such a dilution of stock that the issuer would be unable to meet the most ordinary dividend requirements.

It would appear, therefore, that this form of financing new manufacturing equipment on time has much to commend it. It only remains to add that a great deal depends upon the selction of the finance company. At present, there are only a few in the field of established resources, reputation, and business methods. One of them, for example, has resources of $100,000,000 and had a net volume of industrial lien notes in 1937 aggregating $1,000,000,000.

The need for such financing is so evident that others of less responsibility may be attracted to the field, which means prospective borrowers should make a thorough investigation.

Watch What You Ask of Your Drives

When radical changes are made either in loads or in operating conditions, it's nothing more than good business to make sure your power drives aren't asked to do things their design won't permit

WILLIAM STANIAR
Mechanical Power Engineer
E. I. du Pont de Nemours & Company
Wilmington, Del.

AFTER a considerable period of satisfactory operation, trouble began to be experienced with the drive for a large mixing drum. This revolving drum is 12 ft. in diameter, 10 ft. long, and is supported at each end by heavy trunnion bearings. Formerly it was driven by a 50-hp., 860-r.p.m. motor through a silent chain to a headshaft and thence by a herringbone pinion and ring gear, as shown in Figure 1. The ratio of the chain drive was 5.7 to 1, resulting in a headshaft speed of 150 r.p.m., and the ratio of the herringbone gears was 12.5 to 1, giving a speed of 12 r.p.m.

As mentioned, this drive was satisfactory until a straight mixing operation in the drum was changed to a process of thickening. This change resulted in large quantities of the material clinging to the inside of the shell. As the drum revolved the mass was carried to the top and over the center. At this point the mass would break away and fall forward radially against the shell. Since this action caused a pulsating acceleration of the drum beyond the applied speed, it resulted in continuous jerking and eventually failure of the silent chain drive.

This operating characteristic of a falling load was caused by the nature of the material being worked; therefore it was immediately obvious that a different method of driving was compulsory. A silent chain, or a finished-steel-roller chain, will dampen out vibration and occasional shock loads, but continuous jerking or shock gradually produces pitch elongation, riding of the sprockets, and eventually total failure.

It so happens that there is a device available for overcoming the destructive effect produced when driven equipment is forced ahead of the drive. This device permits the driven shaft to be released without shock from the driving unit, allows the latter to advance the required distance, and then picks up the load again at the regular speed. It is known as the reversible mechanical slipring starter.

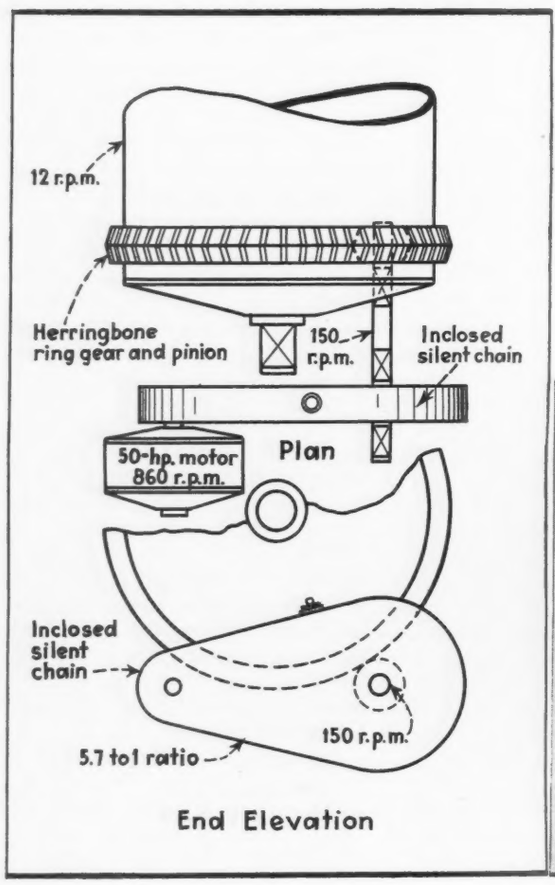
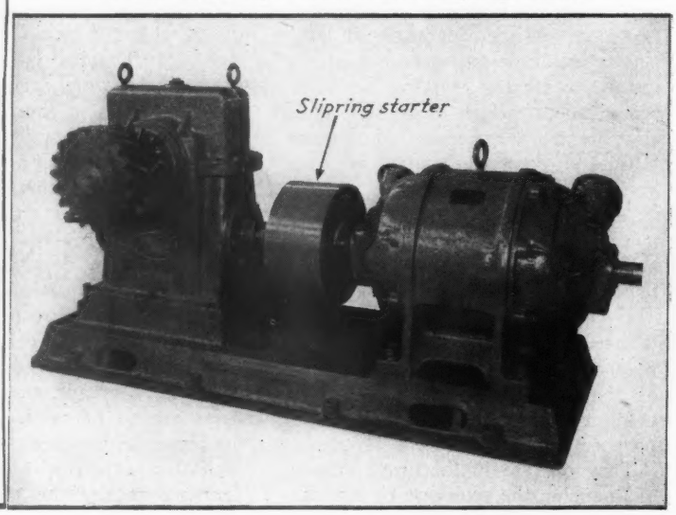


Figure 1. This drive for a mixing drum was satisfactory until a change in the material treated radically altered the operating conditions

Figure 2. The drive in Figure 1 was redesigned to use a worm-gear reduction unit connected to the motor by a mechanical slipring starter



The problem described was solved successfully by the installation of one of these devices, but in view of the necessity of having a 5.7 to 1 ratio between the motor and the herringbone pinion, as originally furnished by the chain, it was necessary to redesign the drive. Figure 2 shows the final arrangement.

A heavy-duty worm-gear reduction unit having a ratio of 5.7 to 1 was coupled to the motor through the slipring starter, which also acts as a flexible coupling, the entire unit being mounted on a cast-iron baseplate. The herringbone pinion drives the ring gear on the drum from the slow-speed shaft of the reduction unit. This drive has now been in satisfactory operation for about three years.

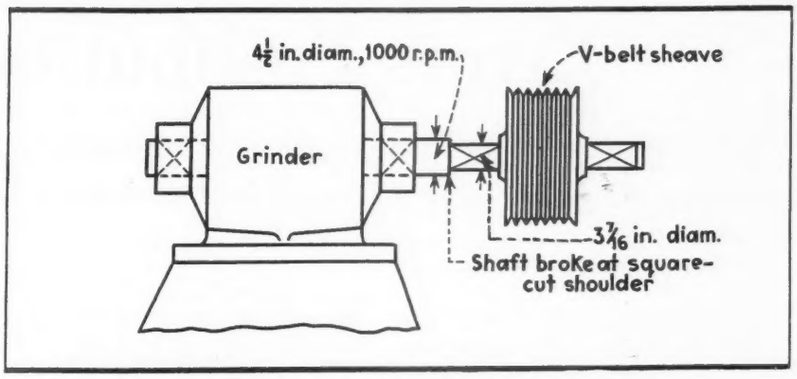


Figure 5. Breakage of a grinder shaft occurred at a square-cut shoulder. To avoid a repetition, the new shaft was turned with a substantial fillet at the shoulder

When Drives Are Stalled

Agitating and mixing operations constitute a major part of the driving problems in the chemical industry. It frequently happens that certain chemical reactions occurring during these processes cause a gradual thickening of the material, which eventually results in jamming the agitating or mixing equipment and destroying the driving mechanism. Electrical overload relays usually are employed to guard against such mishaps, but experience has shown that in a majority of instances destruction occurs before the relay releases the motor from the load. Failures of this character are illustrated by the following example.

The vertical shaft of an agitating tank 5 ft. in diameter and 7 ft. deep is driven by a 20-hp., 1,160/25-r.p.m. vertical motor with inbuilt gear reducer. This driving unit is supported on suitable steelwork on top of the tank, the slow-speed shaft being flexibly coupled to the vertical propeller shaft, as shown in Figure 3. Overload relays protect the motor.

The unit operates without difficulty for a few weeks on a material that possesses thickening tendencies; then, without warning, an instantaneous jam occurs. It happens too suddenly for the overload relays to function and the result is almost complete destruction of the reducer portion of the driving unit, and a bent agitator shaft. On the assumption that possibly some weakness existed in the gears of the reducer, a complete replacement is made. But in a few weeks the same thing happens again.

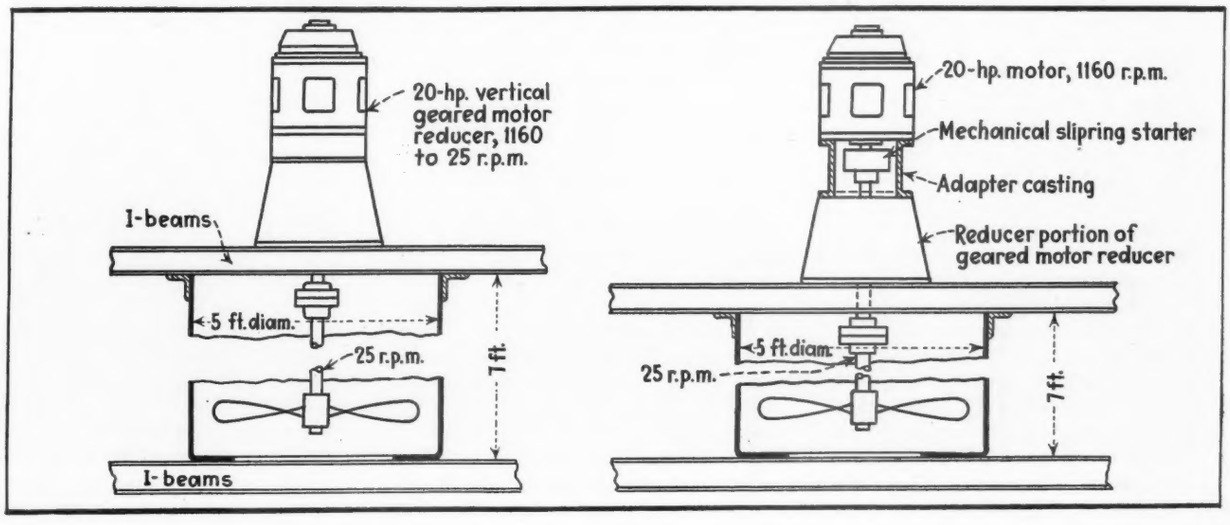
This serious condition was eliminated by utilizing the overload release properties of the mechanical slipring starter. Since the power capacity of this device increases as the cube of the speed, it is always advantageous to apply it to the high-speed motor shaft. In this instance it was not possible to apply the device to the motor shaft, owing to lack of space, unless radical alterations were made to the geared motor reducer. Since the vertical type of drive had to be used, to meet structural conditions, the motor and reducer portions of the unit were separated, and an adapter casting of suitable size to accommodate the slipring starter was placed between them, as Figure 4 shows.

The driving hub of the starter was keyed to the motor shaft and the driven drum was connected to the high-speed shaft of the reducer. This starter was designed to release at 23 hp., or 3 hp. in excess of the maximum peak running load of the agitator. Since the installation of this equipment several jams have occurred without causing destruction, because of the extremely rapid load release.

Electrical overload relays are still employed, but only as a protection to

(Continued on page 130)

Figure 3. A good drive for a mixing tank, but occasional, sudden stalling would result in serious damage. Figure 4. Motor and reducer elements were separated and the shafts joined by a slipring starter, which will release the load when it rises above a predetermined value



Errors Pushbuttoned Out

Errors may be costly; so are usual preventive measures. Campana Corporation cut out both by going to completely automatic production, pushbutton-controlled and electrically supervised

ARTHUR VAN VLISSINGEN
Consulting Editor

FOLKS who like to play with ideas have long contemplated the possibility that eventually our factories might become so completely automatic that the workers would have nothing to do but push buttons. Of course, it seemed far-fetched—and still does. But anyone who has studied the processes in the new plant of Campana Corporation at Batavia, Ill., must admit that 100 per cent automatic production has been removed from wild-eyed dreaming and brought down to a level where even the hardest-headed production executive has to recognize it as something worth thinking about.

Wide Application

Before we examine the Campana processes and the equipment that makes them possible, let us stop long enough to get off on the right foot. In the first place, the only interest that the manufacturing processes of this plant hold for men in other lines of industry, except for curiosity, is in the principles involved. The equipment is single-purpose, and could no more be used for any other plant than could the single-purpose special machinery that makes such little gadgets as safety pins and nails and capsules. The methods of controlling operation of the equipment, however, will unquestionably be widely adopted and adapted when and as they become better known. And the general principles by which it is all accomplished are of almost universal interest.

With this preliminary understanding then, and with mutual awareness that we are interested only in the over-all scheme of production and have no illusions that the machinery used in making a hand lotion could be adapted to turn out, say, cold-rolled steel, let's look at the Campana manufacturing department.

Only one operation in making the product is performed by hand. This consists of blending the essential oils that go into the product. Because of their susceptibility to deterioration from heat and light, these high-priced ingredients are stored in a vault kept at a constant temperature of 50 deg. F. The perfume chemist, who works most of the time in his laboratory, comes to this storage room periodically to make up batches of perfume, He weighs the different ingredients, blends them, then mixes them with alcohol.

Figure 1. Weighing and mixing of all ingredients are controlled from this board on the third floor. The eight-position, pre-mix turntable is located at the right

This concentrate is held to a specified strength by using a scale equipped with photoelectric cell cutoffs. The batch of essential oils must have exactly the right weight to depress the scale pointer so that the latter breaks the beam thrown from a light source toward the electric eye behind the scale dial. Interrupting the beam of light turns on the valve from the alcohol tank, starts the alcohol pump, and keeps the alcohol flowing until another electric eye cutoff on the scale stops the flow. From this point manufacturing processes are automatic.

The weighing control that shuts off the flow of alcohol also opens the outlet valve and starts another pump. The concentrate thus moves to storage in a tank above another scale and the automatic weighing, mixing, and processing begin.

For proper comprehension of the procedure, we must realize that the plant, and this department, makes two distinct products. One is a hand lotion, Italian Balm, which is identified as "B", in all of the plant code systems. The other is a cleansing liquid, Dreskin. Both are liquids and susceptible to the same general sort of manipulation. But the formulas are entirely different and the steps in compounding vary accordingly. The remarkable fact is that the same equipment is used for compounding both products, the difference from the factory standpoint being purely a matter of which side of the control board is used to conduct the operation.

Figure 1 shows the operator who runs this department and does all of the production work on both products. As shown here, he is standing at the control board and manipulating buttons on the right-hand side of the panel, which means that Dreskin is being produced. And because he is pressing the seventh button from the top of the board, he is starting the material into the seventh stage of the process.

He Gets the Key

When this operator receives a production order for Dreskin, say, he goes to the head chemist and obtains the key to the right-hand panel of the control board. With this key he unlocks the cover and lowers it to the position shown. The left-hand panel, controlling the production of Italian Balm, remains locked; therefore the cover is in place and the controls are out of reach.

The control board is so designed that electric relays interlock the various pushbuttons and indicating

lights, making it impossible for the operator to do anything but push the various buttons in proper sequence. Starting at the top of the panelboard the operator pushes the first button, which energizes the electrically operated valves on the pipe lines and lights a red signal lamp. The various valves which are energized open or close as required, so that there is no possibility of the operator using the wrong tanks in connection with the various processing functions that follow. The signal light shows that all valves are energized and it stays lighted until all valves have closed or opened properly. If any valve is stuck or does not seat the light will stay on; then the operator must check it.

If all valves operate in accordance with the pre-determined setting, a green light comes on and the operator can then push the second button from the top. When this is done, the first green light is turned off and the second red light comes on, indicating that the agitator in the concentrated oil tank has started. This agitator continues to run throughout the weighing process from this tank, but at the end of 5 min. the green light opposite the second button comes on as the red light goes off, and permits the operator to push the next button. It brings a scale controlled by a photoelectric cell into the circuit. A supply valve from the concentrated oil tank opens over the weigh tank of the scale, which is equipped with a photoelectric cell, and the contents drain into the scale tank.

Here's Control

The solenoid valve through which the concentrated oils drain into the scale tank is a two-way valve. It is so designed that a heavy flow of liquid takes place through the larger orifice until the tank is almost to the proper weight; then the interceptor in the scale shuts off the large orifice supply and permits a dribble feed through the small orifice, bringing the contents of the scale tank up to the proper weight within a fraction of 1 per cent. Then it automatically shuts off. When the feed shuts off the discharge solenoid valve automatically opens and the tank drains its contents into the pipe line on which the valves have been set by operation No. 1. When the scale tank contents are drained out and the indicator arm returns to zero, the discharge valve from this scale tank automatically shuts off and the green light comes on opposite station No. 3, indicating to the operator that he should manipulate the next button.

There is no need to follow the material step by step through the department. Suffice it to say that the operator pushes a button, gets the red signal, waits until the green signal comes on, then presses the next button, and so on. Each button must be pushed in proper sequence or no operation will start. At each step the master panel control throws the necessary switches, starts pumps or opens valves, or both. The material flows until the scale which controls it registers the required weight; in each instance the pointer of the scale breaks a light beam playing on a photoelectric cell, closing the supply valve and opening the scale tank discharge valve, thus starting the next process.

The order in which ingredients are handled has been chosen so as to make the system self-cleaning, so to speak. For example, assume that essential oils have been allowed to flow through the pipe line into the proper tank. Then the next ingredient weighed in the scale will be alcohol, which will clean out the scale tank and pipe line so that none of the oils will be left in them. If the next product to be made is Italian Balm perfume essence there will be no chance of contamination.

All of the various ingredients

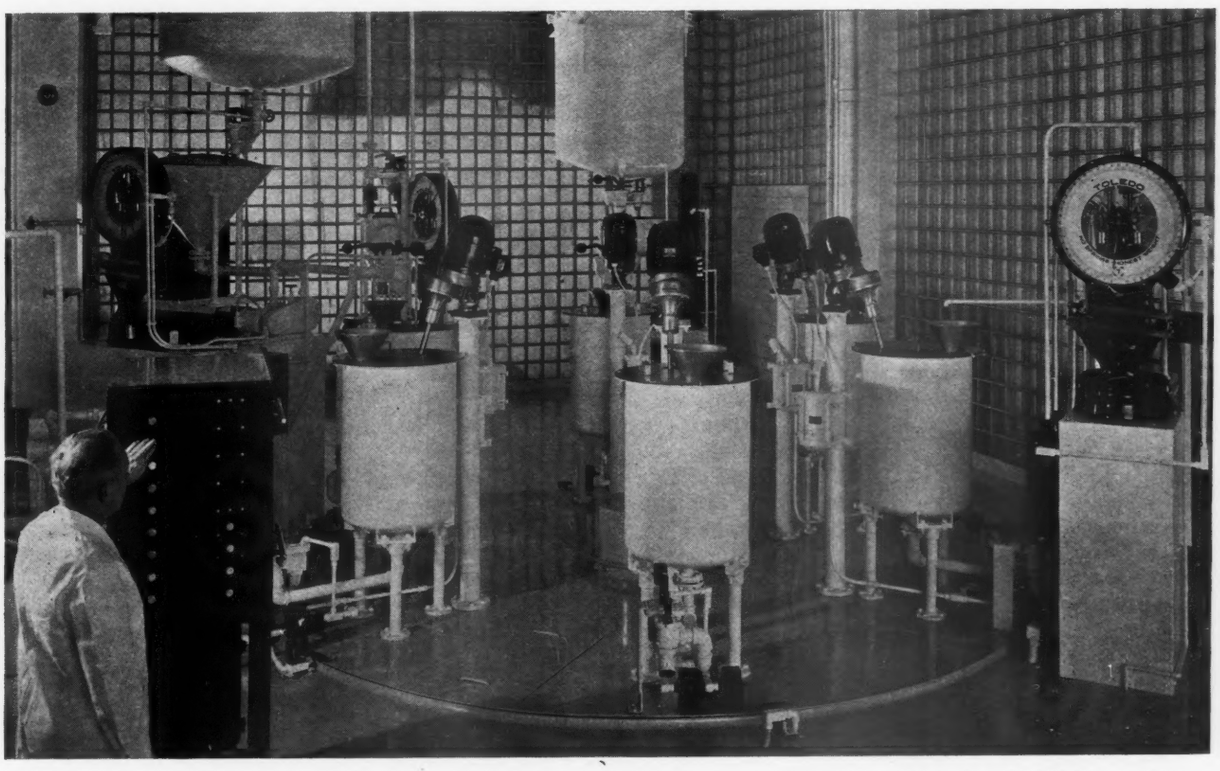


Figure 2. Six glass-lined tanks, with individual agitators, are mounted on the final-mix turntable on the second floor. This turntable makes one revolution an hour and is controlled from the board at the left

drain down into the auxiliary aging tank for agitation and aging.

As mentioned above, each ingredient is automatically controlled by weight. All of the processes are electrically interlocked so that diverting valves are opened when a material is made, agitators start at the proper time, and so forth. In its essentials, the equipment is so designed that once the operator starts on a batch of product—whether "B" or "D"—each ingredient is automatically introduced in the right quantity and in sequence, agitation takes place at proper intervals, and the batch is completed before the operator can start another batch of either product.

Any temporary interruption of electric service does not disrupt the operations. It merely stops everything at the point of interruption; when the power goes off, the valves all close. When the power comes on once more, the valves open and the process starts up right where it left off. Incidentally, because of possible accumulation of alcohol vapors, and to control proper aging, the room is air conditioned. The controls are interlocked with a flutter damper in the exhaust duct, so that if at any time the ventilation ceases the machinery shuts down and cannot be turned on again until ventilation once more becomes positive.

Precision Assured

An automatic turntable, Figure 2, on the third floor is used to make up the pre-mix for the Italian Balm.

This turntable is automatically indexed for one-eight revolution at a time. Each move brings the eight tanks on the turntable to position under the various charging units. Here, again, precision is assured by eliminating the human element of fallibility. At a station where a liquid ingredient is added, the pre-mix tank halts. The liquid drains by gravity from an overhead supply tank through an electrically operated solenoid valve to a scale tank. An indicator arm breaks the beam on an electric eye when the proper amount has flowed into the scale tank. Then the solenoid valve from the supply tank automatically shuts off and the solenoid valve at the base of the scale tank opens to drop the ingredient into the pre-mix tank.

After this sort of thing has been happening at all charging stations simultaneously—with different ingredients being handled at each station, of course—and the necessary time has elapsed for mixing, the turnable is moved ahead one position and the cycle repeats itself.

Addition of dry or powdered ingredients is handled by an electric vibrator conveyor which is started and stopped automatically by photoelectric control.

Interlocking electrical controls prevent the turntable rotating past a charging station, and also prevent charging unless the turntable has properly emptied the tank which finished its cycle at the discharge station. Nor can the turntable remove the tank from the charging position until it has received its proper quantity of ingredients.

One hour is allowed for processing at each station. Hence, the turntable makes one complete revolution in an 8-hr. working day. In terms of production eight tanks of pre-mix are made in a working shift.

Discharged to Storage

From the pre-mix turntable (which is on the third floor) the materials are discharged into storage tanks near the ceiling of the floor below. In this second floor room the final mixing and compounding operations are performed in a fashion very similar to the third floor pre-mixing.

On the turntable on this floor there are six glass-lined mixing tanks, each equipped with its own agitator. The capacity of each of these tanks is just one-sixth of that of a tank on the floor above. This turntable is indexed to six positions, most of which are for injecting new ingredients; so its speed is considerably greater than that of the larger turntable above it. Specifically, the six-station turntable makes a turn in exactly one hour.

It is all geared together perfectly. The third floor or pre-mix turntable holds eight mixing tanks, each containing six times as much material as is needed by each single tank on the second floor or final-mix turntable. The pre-mix turntable makes one revolution per day, producing enough pre-mix for 48 tanks or batches of final mix. The final-mix turntable holds six mixing tanks and makes one revolution per hour, thus giving 48 tankfuls in eight hours.

To double the production it will merely be necessary to add another shift. To triple production, work three shifts. When and if the six-hour day comes, work four shifts. There is space enough on each floor to accommodate another turntable unit and auxiliaries which means that it will be possible to multiply the present capacity by six without enlarging the building.

All final-mix tanks are emptied at the end of each week and since the final-mix turntable is completely automatic, when once put in operation, it is necessary to control the starting of this turntable so that empty tanks will not receive final ingredients and reach the discharge station before the initial ingredient has been added. This is done through an individual control board.

On Monday mornings the operator starts his turntable by pushing various buttons in sequence on this control board. These control buttons are electrically interlocked, the same as the control buttons on the board on the third floor; hence each button must be pushed in order. After the operator has rotated the turntable and automatically filled the tanks so that they are in their proper sequence he comes to the last button on the board. When pushed it throws the table on fully automatic operation. It will then continue to index itself once every 10 min., one tank discharging and the other tank taking on its ingredients in proper sequence.

Mistakes Can't Happen

Since the turntable is automatically controlled and electrically interlocked, it is impossible for a mix tank to pass an ingredient station without stopping and receiving its charge from that station. If a tank does not receive all of the ingredients required, the light beam on the photoelectric cell will not be intercepted and the turntable stops automatic operation until the full amount has been added.

If a tank moves up to the discharge station and the auxiliary tank on the floor below is not empty enough to take this final-mix tank charge, a float switch electrically connected to and interlocked with a solenoid switch is in such position that the solenoid will not open. Then the tank is not permitted to discharge its contents and automatic operation of the turntable is stopped. When the auxiliary tank on the floor below discharges its contents and the float switch drops, the circuit is cut back in, the pre-mix tank discharges, and at the end of a 10-min. interval the turntable indexes itself and automatic operation continues.

At the end of an 8-hr. shift the

(Continued on page 128)

219 Fires, But Only $60 Damage

Back of that record are good fire-fighting equipment, men trained to use it effectively, well-directed fire prevention work

J. R. ELDRIDGE
Chief, Fire Prevention Department
Endicott-Johnson Corporation
Johnson City, N. Y.

A FACTORY that has never had a fire may be proud of its record but, at the same time, it may be in a position of real danger. Perfect fire prevention is a practical impossibility. In any plant where there are combustible materials, something is bound to catch fire sooner or later; if this outbreak comes as a surprise to management and men, and catches them unprepared, the consequences may be serious.

At the Endicott-Johnson plants we have a fire prevention system which we feel is about as good as any factory has; nevertheless, we usually have more than a hundred fires a year. But our annual fire losses are low because we are always ready for fires and we snuff almost all of them out before they do any material damage.

In 1936, for example, we had 219 fire alarms. But the total damage to our property by fire was only $59.95. In 1937 we had 234 alarms with a fire loss of $4,815, but this loss was occasioned by a single fire of exceptional character; damage caused by all the other fires was negligible.

Methods employed to protect our factories from fire were, of course, developed specifically for a large organization engaged primarily in the manufacture of shoes, but the principles involved apply to manufacturing industries of almost any size and character.

The principal Endicott-Johnson properties comprise 34 large factory groups lying in the area 12 miles long, between Binghamton and Owego. Besides the shoe factories proper there are tanneries, fiberboard and leatherboard mills, a rubber mill, rubber reclamation plant, carton factory, lumber mill, and printing establishment. Normally, there are about 18,000 employees, who can produce 135,000 pairs of shoes daily.

Buildings are chiefly of the heavy-timber, frame type or of fire-resistive construction, with adjoining structures and sections of large areas properly cut off by standard fire-doors and shutters. All principal buildings are equipped with automatic sprinklers and inside standpipes. Hydrants and hose houses are located at strategic points outside.

The main fire hazards do not differ greatly from those encountered in many other industries. They include:

1. Common hazards due to heating, lighting, and power systems, and the presence of large quantities of combustible materials.
2. Flammable liquids.
3. Waste materials subject to spontaneous combustion.
4. Combustible dusts.

Responsibility for protecting the plant from fire rests on the Fire Prevention Department, which consists of a chief, two assistant chiefs, four captains, four lieutenants, 90 firemen (who also serve as inspectors and watchmen), a fire alarm supervisor, and other assistants, all on a full-time basis. Its duties are many and varied, but its most important activities are:

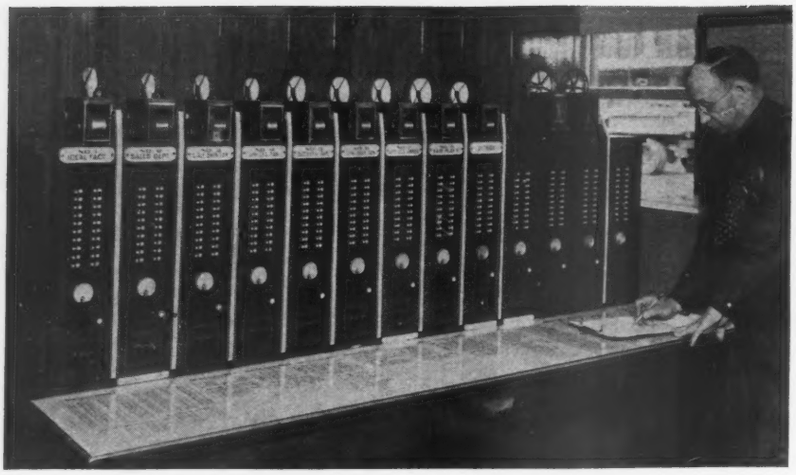
1. Preventing fires.
2. Training regular employees to extinguish incipient fires with chemical extinguishers.
3. Extinguishing fires that are not extinguished by employees on the spot.

Fire prevention work involves the recognition of every fire hazard in the plant; the determination of the methods to be used to safeguard each hazard; the instruction of everyone concerned in the application of these methods; and frequent inspections and drills or meetings to make sure that instructions are being followed.

Common Problems

Many of our major problems in this field are common to many other industries. They include:

1. Safeguarding of raw material storage areas.
2. Safe methods of handling flammable liquids and pyroxylin plastics.
3. Prompt removal and safe disposal of leather dust, sawdust, and other waste materials.
4. Study of potential fire hazards of new materials and new processes.
5. Maintenance of a high standard of cleanliness.
6. Effective suppression of smoking in areas where it is forbidden.
7. Effective methods of inspecting heating systems, electrical apparatus,



All fire alarms, also hourly reports from night patrolmen, are received on this board. An open sprinkler head registers automatically

bearings, and other equipment that may develop hazardous conditions.

Study of hazards is carried on by the Fire Prevention Department officials in cooperation with the company's engineers.

The general factory personnel is instructed in fire prevention at weekly group meetings, held under the direction of the chief officers of the department. At these meetings the men are examined as to their knowledge of established fire prevention methods, and are given instructions regarding new procedures and newly added properties.

Inspection work is carried out by squads of patrolmen who make a complete check-up of all sections of each building every night and report hourly through a signal code over the fire alarm system to headquarters. In addition, the department receives daily reports on the condition of all fire-fighting equipment in the plant and on other matters pertaining to fire protection, from the various department inspectors.

In this way we do all we can to prevent fires, but at the same time we know that in spite of our precautions some are sure to break out. Almost all these fires will, however, start as small ones which can be readily put out by hand fire extinguishers, provided those on the spot do exactly the right thing without delay. Hence the next step in our fire protection program is to train and equip our regular employees so that they will be able to cope effectively with incipient fires.

As a result, over a period of many years more than 70 per cent of all our fires have been put out by hand extinguishers; if we include fires in blower systems on which hose streams have to be used, this percentage rises to nearly 90. Furthermore, because of our set-up, the automatic sprinklers rarely open on fires occurring during working hours in buildings that are devoted to manufacturing operations or are for other reasons well staffed. Consequently, we consider the extinguisher phase of our work of the utmost importance in keeping fire and water losses low.

Employees Know What to Do

Our plan is to train all employees to follow a definite procedure in case of fire. Certain men in each group are selected to operate the fire extinguishers; others turn in an alarm to Fire Prevention headquarters; still others guide their fellow-workers out of the building; and the remainder leave the premises quickly but in an orderly manner.

This training is effected by holding frequent fire drills during which each employee rehearses the part he or she has to play. In addition, all are shown how to operate the various types of extinguishers, so that anyone can use them in an emergency.

To provide the employees with fire extinguishing equipment, several thousand approved hand extinguishers are located in accessible places throughout the plant. This equipment includes chemical-solution (soda-acid) or foam extinguishers, which are used for fires in wood, leather, paper, textiles, and similar materials; vaporizing-liquid extinguishers, which employ a liquid with a carbon tetrachloride base, for electrical fires; and foam or vaporizing-liquid extinguishers for flammable liquid fires.

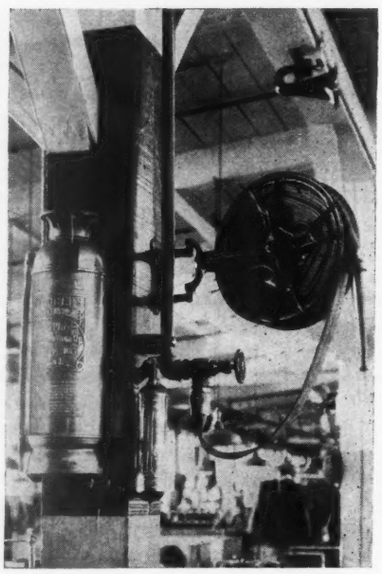
Posts on which each type of extinguisher is mounted are distinctively marked. Thus a red band 3 ft. wide indicates a chemical-solution or foam-type extinguisher; a red band 18 in. wide, a vaporizing-liquid-type extinguisher; and a red band near the top of the post, a hose reel. Fire alarm boxes, of which there are several hundred in the plant, are mounted on posts whose upper half is painted red.

An alarm is sent in to Fire Prevention headquarters whenever a fire, no matter how trivial, breaks out.

As mentioned previously, under our system most of the fires in the factory buildings are out before the squad arrives. In such cases an investigation is conducted to make sure that there is no further danger of fire, to ascertain the cause, and to determine what steps should be taken to prevent a recurrence.

If the fire is still burning when the fire squad arrives, these men take charge and combat the fire with hand extinguishers, hose, or whatever means may be required. Actually, hose streams are rarely needed on fires occurring in the factory buildings; they are more frequently used on dump and other outside fires.

To supplement the factory fire-fighting equipment, the department has two motorized fire trucks carrying 2½- and 1¼-in. hose. These hose lines are supplied from the hydrants, which in turn are served by seven reservoirs having a total capacity of 13,000,000 gal. In addition, seven fire pumps with a total rated capacity of 100,000 g.p.m. stand ready for operation whenever needed.



Thousands of hand fire extinguishers are located in accessible places throughout the plant. Columns on which they are mounted are distinguished by a red band

We've Learned More About H.I.M.V. Lamps

And practical experience shows that when you install them some things should, and others shouldn't, be done—to get all the advantages these efficient light sources offer industry

J. H. WENNER
Lighting Division
Westinghouse Electric & Manufacturing Company
Cleveland

HIGH-INTENSITY mercury vapor lamps were introduced more than three years ago. Since then thousands of these light sources have been put in service and it may be well to summarize the experience gained, as a guide to further application.

Use of mercury as an illuminant is not an innovation in this type of lamp. It has been used, under low pressure, for more than twenty years. However, mercury vapor at relatively high pressure, as in the so-called high-intensity lamp, affords the important advantages of:

1. More efficient light production.

2. A more compact arc steam.

3. A much shorter light source, easier to handle and to apply.

Advantages They Offer

In general, then, high-intensity mercury vapor lamps:

1. Are now the most efficient light sources applicable to industrial requirements.

Although many improvements have been made in the tungsten filament lamp since its introduction in 1907, it is now approaching the practical limit of efficiency at about 15 to 20 lumens per watt, whereas the high-intensity mercury lamp now gives about 40 lumens per watt.

2. They furnish light of the best seeing quality.

Ability of workers to see quickly, more accurately, and with less eye fatigue over long periods under high-intensity mercury vapor illumination has been demonstrated.

3. They combine well with tungsten filament sources.

Where color discrimination is necessary high-intensity mercury vapor lamps, predominant in green and yellow, are often combined with tungsten lamps, rich in red output. Thus, relatively economical color correction is accomplished since the method is additive rather than subtractive, as in the case of light-absorbing, color-correcting media.

4. They have a long useful life.

The two larger (400- and 250-watt) lamps have a rated average life of 2,000 hr. as compared with the 1,000-hr. average life of the larger tungsten filament lamps. In high-ceiling, industrial areas where maintenance is costly, this advantage is obvious. Frequent restarting, however, shortens lamp life.

With the recently introduced 100-watt, high-intensity mercury lamp, there are now four commercial lamps available: the 400-watt, type H-1; 250-watt, type H-2; 85-watt, type H-3; and 100-watt, type H-4. The more important characteristics of these lamps are given in the table.

In the order of their popularity the 400- and 250-watt sizes have found general industrial application. The 85- and 100-watt sizes, although more efficient than the largest tungsten lamps, are low in total light output as compared with the larger mercury lamps; hence their application to the general lighting system is not generally recommended. They are sometimes used for localized or inspection lighting where a source smaller than 250 watts is desirable.

The 85-watt lamp has a medium screw base and can be used in some types of 250-watt lighting equipment. A special base prevents similar use of the 100-watt lamp unless a change of socket is made. Both of these lamps are efficient short wave (ultra-violet) sources and find application in the production of fluorescent and phosphorescent effects. While these applications are interesting, if not spectacular, they are very restricted and not within the scope of this discussion.

The 400-watt lamp consists of two glass bulbs—the inner or arc tube, which is the light source, and the outer bulb which serves as a heat-insulating jacket and mechanical protection for the arc tube. At either end of the inner tube are two electrodes of coiled tungsten wire coated with an electron-emitting material (barium-strontium oxide) which facilitates starting. The third or starting elec-

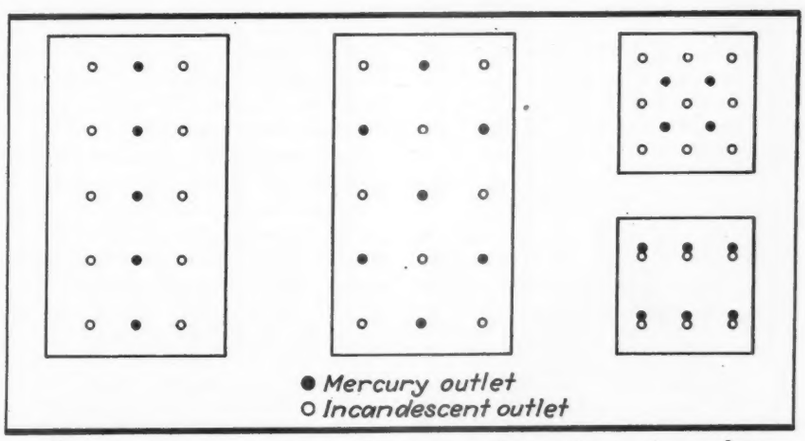
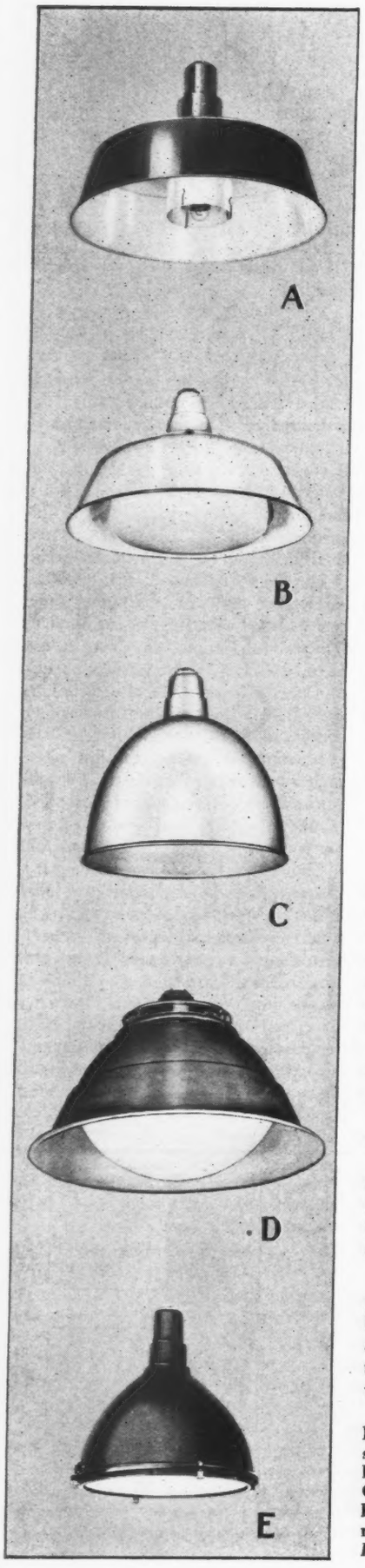


Figure 1. Four arrangements of mercury and incandescent lamps that will give good mixture of colors



trode, a noteworthy improvement, is located close to the base-end main electrode. It is connected through an inner resistor to the main electrode at the opposite end of the tube and assures positive starting in cold weather, as well as quicker restarting after a current interruption.

The inner tube contains mercury, carefully measured to assure proper pressure after vaporization, and a small amount of argon gas to facilitate arc establishment.

The 250-watt lamp is quite similar in principle, but it differs radically from the larger lamp in two respects:

1. It has a single bulb of quartz glass with a very high melting point. The single-tube construction requires that the lead wire to the lower (tip) electrode be incased in heat-resisting glass—an innovation in this lamp—and that the tip be coated with platinum to reflect heat, preventing mercury condensation.

From a lighting application standpoint, the single-tube construction makes the lamp susceptible to air currents and resultant temperature changes. This necessitates that it be used only in inclosed fixtures to maintain light output.

2. It may be operated in any position.

Operating Characteristics

From this standpoint, it is more flexible than the larger lamp. It operates at a lower pressure; so the arc is less constricted. It should be noted that the 400-watt lamp may be operated only base up or base down, with a deviation of not more than 10 deg. from the vertical. Greater deviation causes the arc stream to bend against the wall of the inner tube, melting it, and destroying the lamp.

In starting and operating characteristics the two differ as follows:

	400 Watt	*250 Watt*
Starting volts	20	20
Starting amperes	5	5
Operating volts	150	70
Operating amperes	2.9	3.9

When starting, the argon gas supports the arc. After a few seconds a blue glow of low intensity fills the arc inclosure as the mercury starts to vaporize. At this stage the starting values given above prevail. As vaporization continues voltage increases and current decreases until after approximately 10 min. the full intensity of the arc is attained and the above operating values obtain.

In the event of current interruption, or a considerable dip in line voltage, the arc of these lamps will be extinguished. When this occurs restarting will take place only after a cooling period of 3 to 5 min., depending on the operating conditions, which is necessary to reduce the pressure to the starting point.

Figure 2. Reflectors especially designed for high-intensity mercury lamps. *A*, conventional dome; *B*, Glasteel diffuser; *C*, aluminum, high-bay unit; *D*, 400-watt, combination mercury-incandescent unit; *E*, dust-tight, vaporproof unit

Alone or in Combination

In general, there are only two types of high-intensity mercury vapor lamp installations:

1. Those in which the mercury lamp is the principal source.

This type of installation is generally recommended for industrial interiors where illumination of high visual quality is desired, color discrimination is not necessary, voltage regulation is reasonably good, and variable-speed machinery is not used. It embraces a great majority of the so-called heavy-industry interiors. In this type of installation the addition of a low-level, general system using tungsten lamps is advisable as a safeguard against complete darkness if a current interruption causes an outage of the entire mercury system.

2. Those in which tungsten filament lamps are used in conjunction with the mercury lamps.

Where discrimination of color is essential, where variable-speed machinery is used, or voltage is subject to excessive fluctuation, an installation combining the two types of sources is always recommended. It overcomes three objections to the all-mercury type of installation: color distortion, stroboscopic effect, and failure of the lamp to restart immediately after a current interruption.

Due to the characteristic yellow-green color of mercury light certain colors, notably all shades of red, are distorted. The addition of tungsten sources with a continuous color spectrum rich in red completely overcomes this difficulty.

Stroboscopic or "flicker" effect of mercury lamps causes high-speed machinery to appear to slow down, or even completely change direction of rotation. It is largely overcome by introducing the stable incandescent source into the system. For further correction it is recommended that alternate mercury lamps be connected on opposite phases of the wiring sys-

tem. This is especially advisable where three-phase service is available. Such connection greatly reduces the stroboscopic effect.

Line voltage dips on the order of 10 per cent, with a duration of two or more cycles, will cause the mercury arc to quench. Under these conditions the addition of incandescent sources guarantees continued production during the period required for restarting and return of the mercury arc to full brilliance.

The combination type of installation may involve the use of luminaires containing one mercury and from one to three incandescent sources, or units of one type may be alternated with units of the other type. There is no set rule for choosing between these methods, but experience dictates use of the former for mounting heights under 18 ft., and the latter above that.

Likewise, there is no hard-and-fast rule for determining the proportions of mercury and incandescent light, but experience shows that equal amounts of each, lumen for lumen, will produce light approaching daylight color quality, which is usually satisfactory. However, installations ranging all the way from a 2-to-1 ratio (mercury to Mazda) to a 1-to-2 ratio have been found satisfactory for certain applications.

Careful Planning Needed

Installations in which mercury and incandescent sources are alternated must be carefully planned if a good mixture of colors is to be obtained. Four accepted methods of accomplishing this result are shown in Figure 1. However, in adopting any method of combination from individual units, the importance of selecting lighting units to provide light distribution with sufficient overlap cannot be over-emphasized. It is the secret of good color blending.

Equipment for mercury vapor lamps is quite similar in general type and appearance to standard incandescent lighting equipment. However, specially designed reflector equipment is required for proper light control and minimum glare because the mercury light source is so much larger than that of incandescent lamps.

Spacing of outlets is a definite function of the available mounting height and the foot-candle intensity desired. Design tables and recommended levels of illumination for all types of industrial interiors can be obtained from lamp manufacturers. Performance tables for each specific fixture design are, in most cases, furnished by the lighting equipment manufacturers.

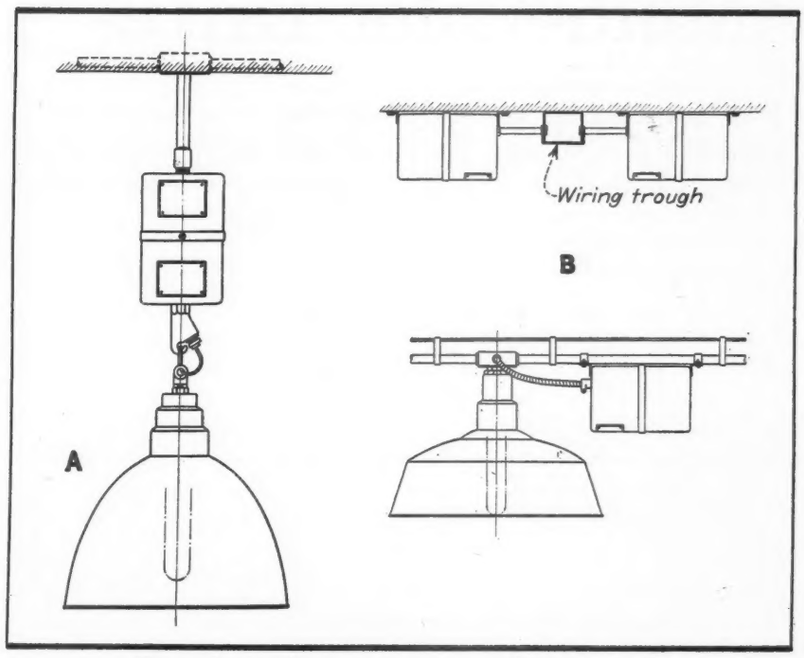


Figure 3. Auxiliary reactors or transformers may be mounted, *A*, in the conduit line or, *B*, on the ceiling

CHARACTERISTICS OF HIGH-INTENSITY MERCURY VAPOR LAMPS

	400 Watt, H-1	*250 Watt, H-2*	*85 Watt, H-3*	*100 Watt, H-4*
Bulb (tubular shape)..	Tipless T-16	Tipped T-9	Tipless T-10	Tipped T-10
Base (screw type)....	Mogul	Medium	Medium	Special (No. 1864)
Finish of bulb.....	Clear	Clear (coated end)	Clear	Clear
Lumen output.....	16,000	7,500	2,975	*3,000
Lumens per watt.....	40±10%	30±10%	35 (initial)	*30
Average life, hr.....	2,000	2,000	500	500
Over-all length, in....	13	8	5⅝	5⅝
Light center length, in.	7¾	5	3	$3\frac{7}{16}\pm\frac{1}{8}$
Arc length, in.....	6	4½	1½	1½
Burning position.....	Base up (Down when specified)	Any	Any	Any

* *After 100 hours.*

Figures 2 *A* and *B* illustrate the conventional dome and Glassteel diffuser designed for general application with 400-watt lamps at mounting heights of 12 to 18 ft. In the dome unit a shield of diffusing glass reduces glare by improving the light cutoff and shielding the lower portion of the lamp from direct vision. The Glassteel diffuser utilizes an opal globe which completely incloses the lamp and, like the similar incandescent unit, provides illumination with a high degree of diffusion. About 6 per cent is transmitted to the ceiling through openings in the top.

Typical of high-bay reflectors is the aluminum unit for 400-watt lamps, shown in Figure 2 *C*. Units of this type are available in specific light distribution for low (18 to 30 ft.), medium (31 to 45 ft.), and high (46 ft. and over) mounting.

The 400-watt combination mercury-incandescent luminaire, Figure 2 *D*, is widely used. It is suitable for combining the two types of sources at mounting heights of only 12 to 18 ft. The three incandescent lamps are equally spaced about the mercury lamp, which results in excellent color mixture, uniform heating and cooling of the mercury lamp, and good color correction, since the smaller incandescent lamps have a greater output in the red band of the spectrum. Maximum flexibility is possible with this unit because the incandescent sockets may be equipped with

(Continued on page 126)

Multi-Motor Drives

Ever have trouble running conveyors in sequence, or operating two or more motors on one drive? Here are a number of good answers to problems of this kind

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Industrial Department
General Electric Company
Schenectady

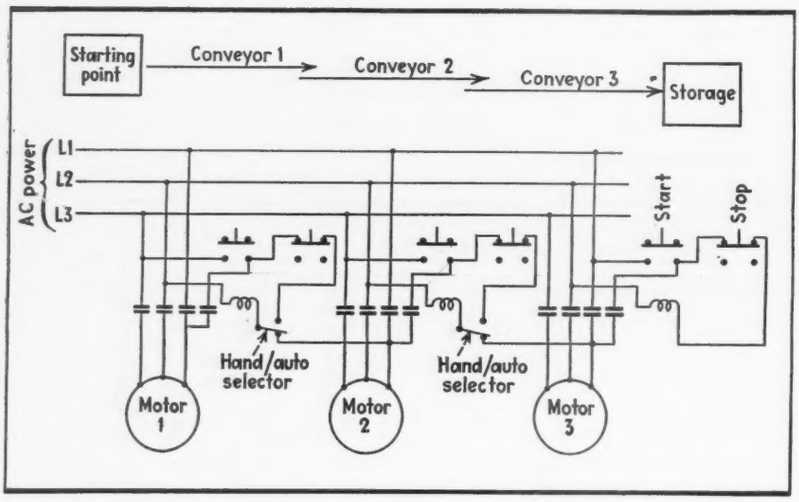

Figure 1. With controls interlocked in this way material has no chance to pile up. Conveyor No. 3 must start first: shutdown of any conveyor stops all others ahead of it

APPLYING a motor to drive a single belt conveyor usually is not a difficult matter. Experience has shown that a squirrel-cage induction motor exerting approximatetly 200 to 225 per cent starting torque will take care of the requirements, provided the load imposed by the conveyor does not exceed the continuous full-load motor rating. For exceptionally large drives wound-rotor motors are sometimes used with motor-operated drum controllers to give extended periods of acceleration. When a multiplicity of conveyors is operated, or more than one motor is required to drive a single conveyor, the problem becomes more involved.

Aside from the operation of a single conveyor by itself, probably the simplest and most commonly encountered conveyor drive is where bulk material such as coal is transferred from one remote location to another over a number of belt conveyors in series. Such an installation is shown in Figure 1. Motors *1*, *2*, and *3* drive three conveyors which pass material from one to the other in the order given. The control is so arranged that conveyor *3* starts first, *2* second, and *1* last. With this arrangement all the conveyors in the sequence are running before the conveyor nearest the source of supply has started up.

Under these conditions it is impossible for the first conveyor in the sequence to run and start the material flowing until all the succeeding conveyors are in operation. An accidental shutdown of any conveyor in the system will stop all conveyors feeding it. The remaining conveyors in the sequence will continue to run and clear the system.

Throw-over switches are shown which enable the operator to cut any motor out of the series and operate it alone for the purpose of testing. In this scheme of connections, all motors are energized in sequence but with practically no time delay in the closing of the line contactors.

Such a scheme of control is suitable for small motors, but where large ones are used it may be desirable to extend the starting time so as not to put an undue load on the power system. That can be accomplished by interposing a definite-time-delay relay in the control circuit between each pair of controllers. This arrangement allows the starting inrush current to each motor to reduce to normal before the next starts.

Another method involves use of a speed-limit switch coupled to each motor, except the last one to start, which will not close its contact and provide a circuit for the following motor until the first is up to speed.

One of the most outstanding installations of this character is a coal-handling system installed a number of years ago. Twelve wound-rotor induction motors drive 12-in. belts which travel at 500 f.p.m. and are capable of transporting 12,000 tons of coal in 8 hr. from a central underground loading station to a coal tipple on a river bank.

Nearly Three Miles Long

The total length of haul is 14,000 ft. and the longest single conveyor is 2,200 ft. in length. Owing to the size of the units, wound-rotor motors rather than squirrel-cage motors are used. Extended periods of acceleration are used, to eliminate wear and tear on the large, expensive belts. Interlocking for sequence starting was provided, as well as means for operating each belt independently.

A somewhat similar installation using nine 75-hp., high-torque squirrel-cage motors with sequence-operation magnetic control was recently made at the Spruce open-pit iron mine, Eveleth, Minn. In this installation iron ore is transported a distance of

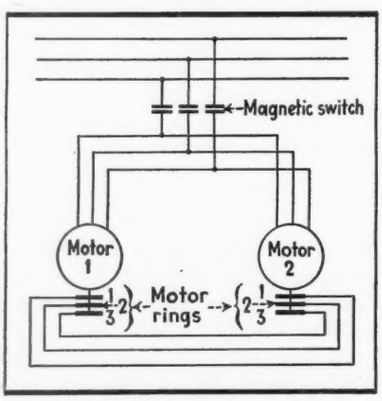

Figure 2. Selsyn motors are locked together by a synchronizing torque produced when the rings are interconnected

4,500 ft. up a net vertical rise of 386 ft. at the rate of 750 long tons an hour. This conveyor system is reputed to be the largest used anywhere in iron mining.

In many industries this scheme of materials handling has been used in preference to other methods.

In the Spruce mine installation all motor drives are equipped with Thrustor brakes so that in the event of emergency shutdowns the belts (particularly those conveying material down-grade) will not over-run when power is cut off, and spill their load at the foot of the inclines.

On installations where a conveyor carries the load down-grade, a brake rated 150 to 200 per cent of full-load torque should not be considered too large, for the following reason: When power is cut off the brake starts to set. A fraction of a second may be lost before the shoes move up to the brake wheel and make contact. Also, since the brake must set smoothly and gradually, the speed will continue to increase until the brake finally exerts a retarding torque equal to that created by the descending load. After that, still more pressure must be exerted by the brake shoes before any retardation of speed can be obtained. With the load going down-grade and the braking effect of the motor removed, the conveyor gains speed.

The stored energy of all moving parts increases as the square of the speed; so that when the brake finally takes hold it may have considerable difficulty in stopping the conveyor without shoes and wheel getting excessively hot.

If the load is being carried up-grade and power fails, the brake shoes will doubtless be exerting full pressure on the wheel by the time the drive has come to rest. When this happens the brake gets the advantage of static friction in holding the load, and the weight of the material on the belt will not be sufficient to start the conveyor moving in the reverse direction.

In most sequencing conveyor drives it is not essential that the various drives in the system run at exactly the same speed. Any slight difference in speed due to differences in induction motor slip or to load variations will not affect the success of the drive where bulk material is carried from one location to another.

In some special cases, however, it is required to run two or more conveyors at exactly the same speed. Synchronous motors can be used. Also, it has been known for some time that two wound-rotor induction motors will run at the same speed, with a common resistor. When using wound-rotor induction motors in this way, it is possible to operate with standard machines of identical rating. They will stay in step with each other, like synchronous motors, while furnishing power for driving a load.

Figure 2 shows a similar connection, except that a permanent resistor is not used. The rings are interconnected and the motors, known as Selsyns, are locked together by a synchronizing torque. They will not exert any driving torque, but if a second motor is connected to one of these units and drives it at a certain speed, then the other motor will also rotate at exactly the same speed. The units will stay in step not only while accelerating and stopping, but if excitation is maintained when power is cut off from the driving unit they will coast to rest, always keeping in exact synchronism.

If excitation is removed at the same time that power is cut off the driving motor, the two motors will not be held in step, and probably will coast to rest out of phase coincidence. If excitation is then re-applied by closing the contactor the rotors will snap into phase coincidence. Then if the rotor of one unit is rotated, the other will also make the same number of revolutions.

If the stators are excited by closing the magnetic switch, as shown in Figure 2, care should be exercised in getting the proper connections between the rings. Whether they are correct can be determined by applying excitation and connecting ring *1* of No. 1 motor to ring *1* of No. 2 motor. Then connect a voltmeter between ring *2* of No. 1 motor and ring *2* of No. 2 motor. The voltmeter can be made to read zero by slowly turning one rotor. After this zero reading has been obtained, connect the voltmeter between rings *3*. If this reading is also zero, the rotor connections can be made and the two units can be operated together.

If the last reading is not zero, however, connect ring *2* of No. 1 motor with ring *3* of No. 2 motor and again turn one rotor until the voltmeter reads zero. Then connect the voltmeter between ring *3* of No. 1 motor and ring *2* of the other. Now a zero reading will undoubtedly be obtained, indicating the correct connection.

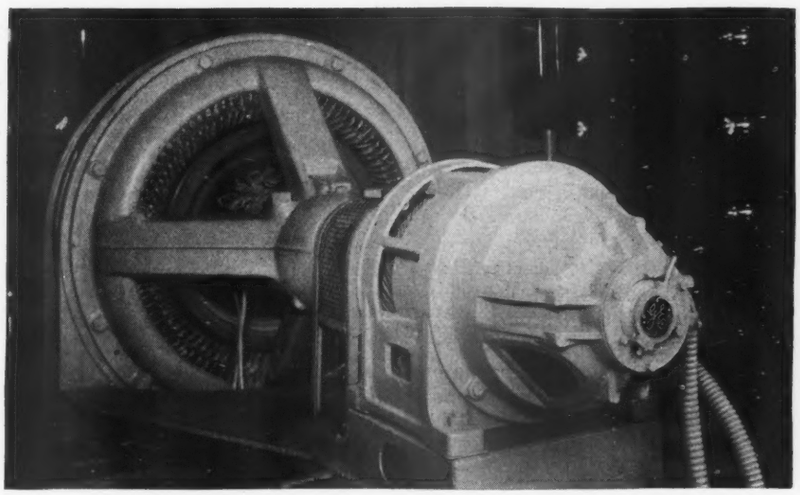

Figure 3. A 125-hp., 350/750-r.p.m. induction motor drives the power Selsyn transmitter in a rock products plant

The foregoing discussion indicates that if two conveyors, or any two drives, are required to be driven in synchronism at different speeds it is only necessary to connect No. 1 motor to one drive and No. 2 motor to the other. Then either unit may be driven by another motor, which may be a varying-speed type; or a constant-speed motor may be used with some kind of mechanical speed-changing device. The two units will then rotate in exact synchronism with each other, governed entirely by the speed of the driving motor. In some applications, notably in the handling of paper, it is customary to drive each Selsyn by its own variable-speed d.c. motor.

Figure 3 shows the transmitter of a Selsyn drive in a rock products plant.

With such a synchronized drive a certain spot on the rotor of the No. 1 motor has exactly the same angular rotation as a spot on the rotor of

No. 2. Likewise, if the motors are each geared through identical gear ratios to two chain conveyors any spot on No. 1 conveyor will synchronize with another spot on No. 2.

In Figure 4 two conveyors are shown which are held in synchronism by power Selsyns, but it happens that points *A, B, C* on No. 1 conveyor do not coincide with spots *A1, B1, C1* on the other. Such coincidence is sometimes required where a series of hooks on one conveyor carrying parts for an assembly line must match up with the hooks on a second conveyor. In such a case it is necessary to be able to change the relative positions of the hooks so that they will meet as they pass. It can easily be accomplished by use of a differential Selsyn, as Figure 4 shows.

This machine is really an induction motor of suitable design with the stator and rotor connected as shown, the rotor being held stationary by a brake. If some means are provided to turn the rotor of the differential Selsyn a few electrical degrees, the fixed relation of points *A, B, C,* and *A1, B1, C1,* on the conveyor will change and it will be possible to bring the required points on one conveyor in exact juxtaposition with those on the other. When this is accomplished, the brake on the differential Selsyn should be set.

If desired, two differential Selsyns can be used in the same circuit so that control can be had at either of two widely separated locations.

Since the differential Selsyn does not rotate it does not have the advantage of cooling by windage. Therefore care must be exercised in selecting a unit which will not overheat.

It should also be noted that the power required for driving No. 2 conveyor is supplied by the drive motor on No. 1. Hence, this motor must be large enough to supply power for both conveyors, and not just for the conveyor to which it is connected.

Power Selsyns have been used for driving long chain conveyors from different, widely separated, places on the chain. Multi-motor drive is desirable for long conveyors because it reduces the amount of strain to which the chain is subjected and if the different drives can be depended upon to divide the load exactly, use of a less expensive chain is permitted. Operation of power Selsyns has not been entirely satisfactory for this type of drive. In fact, care should be exercised in applying them to any drives which are also mechanically connected.

Check Speed-Torque Curves

With one constant-speed chain conveyor trouble was experienced as follows: The chain was installed, and before starting the same amount of slack was obtained between the various drive points. After operation started tension would build up and reduce again between various drives, possibly due to the effect of a number of slightly shorter links in the chain. This trouble was eventually overcome by introducing tension springs in various parts of the drive.

Another scheme would be to introduce the differential Selsyn and arrange the control to crank the differential automatically one way or the other, as governed by the tension.

One successful chain conveyor drive that has come to my attention uses standard, general-purpose, squirrel-cage motors with no Selsyn tie.

This arrangement is perfectly feasible if motors with identical speed-torque characteristics are selected and installed where they are likely to be equally loaded. When making such application it is also desirable to be liberal in motor size because speed-torque curves of motors of the same rating may not always be absolutely identical, which may have considerable effect on the way the motors divide the load.

Referring to Figure 5, *A* and *B* represent the speed-torque curves of two general-purpose induction motors. These curves do not exactly correspond, and if the motors are connected to the same load one will carry 75 per cent of its rated load, while the other will be overloaded 25 per cent.

Two other speed-torque curves which do not exactly correspond are represented by *C* and *D*. These curves represent identical ratings of squirrel-cage induction motors with high-resistance rotors; they would also apply to wound-rotor motors with permanent resistance in the secondaries. Introduction of secondary resistance causes the speed-torque characteristics to have a steeper slope so that the division of the load between the two motors will be much better than indicated in *A* and *B*, where the curves are flatter.

Wound-rotor motors have an advantage over squirrel-cage motors in that it is possible to vary the secondary resistance of one or the other and thus make them divide the load exactly. Of course, this can not be done with squirrel-cage motors.

Another successful installation involves two wound-rotor induction motors, each having a permanent resistor in the secondary. When one motor starts to pull harder than the other, and begins to take up slack in its portion of the chain, a take-up device moves forward and opens a limit switch which causes extra resistance to be inserted in the secondary of this motor and thus reduces its torque. When the take-up device has moved back to its original position, indicating that the chain has the proper tension, the limit switch is reclosed. This arrangement proved to be quite satisfactory, as well as inexpensive.

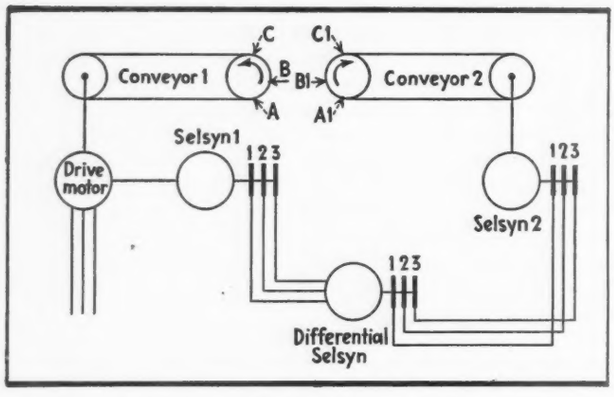

Figure 4. Corresponding points on these conveyors can be thrown into or out of exact coincidence

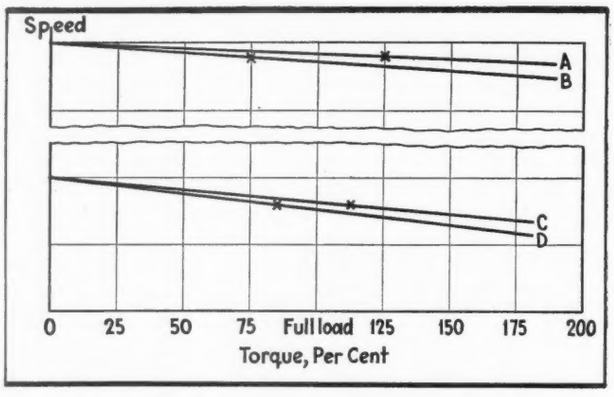

Figure 5. Motors whose speed-torque curves do not coincide will not share a load equally

...the new Greater Exide-Ironclad Battery

EXIDE now makes available to industry a series of Greater Exide-Ironclad Batteries, with abundant power to drive the largest electric material handling trucks continuously for twelve or more hours.

With standard assembly in steel trays of 15, 18, and 24 cells or more, the Greater Exide-Ironclad is available in sizes from 15 to 21 plates per cell —capacities of 700, 800, 900 and 1000 ampere-hours at the normal discharge rate.

• Thus these batteries pack gigantic power into a minimum of space. The 18-cell, 21-plate battery, illustrated, has a capacity of 34.4 K.W.H.—41% greater than that of an 18-cell Type TLM-29 Exide-Ironclad, which is the largest size battery of the TLM Type that can be assembled in the same floor space.

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You want to know

and the editors will gladly tell you more about the things mentioned on this page

• HAND MOTIONS and rhythm appearing in factory work have been research subjects in a motion-study laboratory. Bulletin presents results of the attempt to find fundamental data common to all classes of manual work. (6801)

• LIGHTING HANDBOOK, in a revised and enlarged edition, covers the whole field of artificial lighting. Physiology of the eye and its reaction to light are covered, so that illumination engineers can better comprehend their task. (6802)

• RATCHET WRENCH has torque-indicating feature so that all bolts can be tightened to even tension. When torque pre-set on the indicator is reached, ratchet lever snaps to neutral position. (6803)

• HOURLY WAGES are higher today than they were in 1929, but the typical American worker finds less

GLASS TAPE, for insulating electrical conductors and motor and generator coils, is woven entirely from glass yarns. High temperatures and chemicals will find it resists them, and moisture can be kept out by impregnating the tape with varnish or resin. (6819)

in his pay envelope now than he did then. Pamphlet points this out and shows that occupation is chief factor in income size. (6804)

• TELEPHONE needs no batteries in its talking circuit, for voice current is produced by vibrations induced in diaphragm by speaker's voice. For calling, a battery-powered bell or buzzer is used. Any number of stations can be put on the line. (6805)

• CHANGES in industrial techniques are being studied, in their relation to employment and unemployment, as a national research project. Summary of findings to date has been published. (6806)

• EYE TEST defeats fraudulent claims for injuries. It's another application of polarized light, consisting of polarizing lenses in front of a test-letter projector and before subject's eyes. By turning one lens through 90 deg., letters become visible to left or right eye of subject without his knowing it. (6807)

• "WHAT IS INDUSTRY?" a booklet, shows industry's role in the everyday life of Americans. Industry is America at work, it points out, and the butcher, baker, and candlestick maker grow and prosper as industry prospers. (6808)

• TILE FLOORING, rubber, is smart looking and light in weight. There are inlaid colors, so the sombre office may be in for a bit of dolling up. Other qualities: resilience, sound absorption, fire resistance. (6809)

• GASKETS, of the metal-reinforced type, can be made on the job from any soft gasket material and a reinforcing strip of copper or other metal. Strip is fitted around opening after gasket has been cut; is embedded when pressure is applied; protects the material against pressure, corrosion, and heat. (6810)

• EXPOSURE METER, photoelectric, straps on like a wristwatch, leaves hands free for the camera. (6811)

• PAINT with portland cement and casein base stands up well in sunlight and heat, and acts as heat insulator. It will stick to galvanized iron roof, iron, steel, wood, concrete, and asphalt. (6812)

• GUARANTEEING employment or income to wage earners on a yearly basis is much talked of right now. More and more companies are showing interest, and investigating the plans already in operation. A study of these plans has been published. (6813)

• FLUORESCENT LAMPS give excellent daylight white light. They are tubular in shape, have inside surfaces coated with fluorescent chemicals. Low-pressure mercury vapor discharge produces ultraviolet radiation which the chemicals change to visible light. (6814)

INTRODUCING "Baby Blue," a portable blueprinting machine that will make you a 9x18-in. (or smaller) blueprint. Ready to plug into a lighting circuit, the printer has a case complete with washing and fixing tray, fixing salts, and a supply of sensitized paper. (6820)

• WHEELBARROW concrete mixer is a mighty handy tool to have around where small lots of concrete are needed every so often. While being pushed along, it does a thorough mixing job. (6815)

• RUST SOLVENTS remove severe corrosion without metal loss, it is said. Five types, of different compositions and strengths, are available. (6816)

• ALMANAC published by one manufacturer cost a lot of one editor's time —he found so many interesting facts there. (6817)

• WISE WATCHMEN get that way by keeping their eyes open, finding where danger lies. They learn faster with new report forms that come in sets to cover a year's watching. Twelve monthly pads provide daily sheets, each sheet with a pointer watchmen will find good to know. (6818)

PRESSURE MUST BE MAINTAINED

—to keep bolted assemblies tight

Locking nuts in a fixed position is not enough. Bolted parts loosen *initially—not* because of backward turning of nuts, but because of wear, breakdown of paint, scale, rust or bolt stretching. Only helical Spring Washers . . . with compensating Live Action . . . *maintain* pressures on thread surfaces—friction and adhesion—to *keep* your product *tight.*

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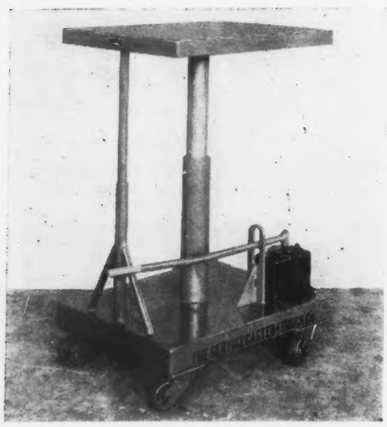
Overload relay for use on a.c. or d.c. Contacts are rated 30 amp. at 110 volts a.c., 20 amp. at 220 volts a.c., 6 amp. at 110 volts d.c. and 3 amp. at 230 volts d.c. on non-inductive loads. Contacts can be arranged to close manually or by means of voltage-operated coil. Struthers-Dunn, Inc., 135 North Juniper St., Philadelphia.

Die Table

Die table measures 30x24 in. in over-all size and will move through narrow aisles without trouble. Height can be adjusted by hydraulic control from 30 to 48 in.



above the floor. Standard models can be supplied for 500, 750, or 1,000 lb. capacity; models custom-built for heavier loads. Mounted on 4-in. steel wheels. The Service Caster & Truck Co., 505 North Brownswood Ave., Albion, Mich.

Expansion Valve

Type TK thermostatic expansion valve has stainless steel spring diaphragm and metal housing welded together to form one piece. It is light in weight and small in over-all dimensions. Has ample filter area and comes in variety of capacities and line sizes. Alco Valve Co., Inc., 2628 Big Bend Blvd., St. Louis, Mo.

Electrode

Page Hi-Tensile G electrode is of the shielded-arc type. Recommended for flat and positioned fillet and general flat welding, and is said to have high speed and be smooth flowing. Suitable for use with either motor-generator or transformer-type machines. High strength and good ductility are features of the weld. Page Steel and Wire Division, American Chain & Cable Co., Inc., Monessen, Pa.

Cable Stop Joint

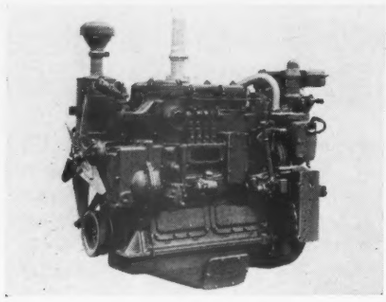
Type SJ cable stop joint prevents oil and compound migration. Consists essentially of two cableheads with wiping sleeves, bolted together about a brass flange. Flange has straight-bore porcelain insulators long enough to overlap conductor insulation; hence no taping is required. Copper connector sleeves with solid wall in middle are soldered to conductor ends. Furnished for various sizes of cables and voltages. G & W Electric Specialty Co., 7780 Dante Ave., Chicago.

Oil Reclaimer

Crankcase, transformer, heat-treating, and other types of oils can be reclaimed with this unit. Quality of oil reclaimed is claimed to be high because the unit has efficient washing and filtering process. Bucyrus-Erie Co., South Milwaukee, Wis.

Diesel Engines

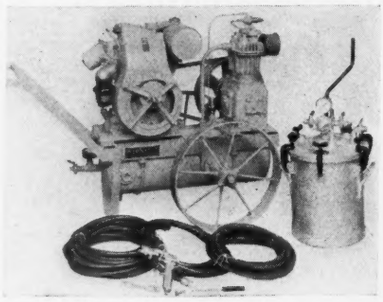
Two models. D3400 is rated 33 hp. at 1,525 governed r.p.m.; D4600, 66 hp. at 1,400 governed r.p.m. D3400 is 4-cylinder engine with 3¾-in. bore and 5-in. stroke, has 10-hp. gasoline starting engine. D4600 is 6-cylinder model with 4½-in. bore and 5½-in. stroke. Both engines feature four-stroke cycle, valve in head, watercooled design, with solid fuel injection into precombustion chambers. Only three operating adjustments —valves, water pump, and fan. Fuel injection pumps and valves are factory set. Caterpillar Tractor Co., Peoria, Ill.



Lift Truck

Model 2500 is a wide-frame lift truck. A four-stroke truck, it can be elevated with handle at any point. All steel except for a few minor parts, it can be furnished with ball or roller bearings. Rubber-tired, steel or semi-steel wheels. Capacity is 2,500 lb. The Yale & Towne Mfg. Co., 4530 Tacony St., Philadelphia.

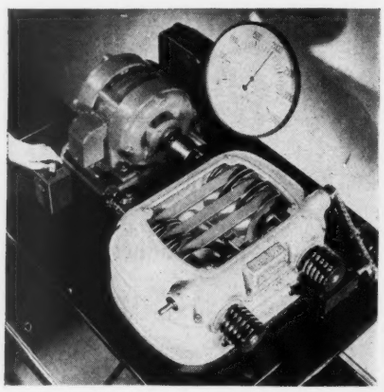
Portable Spraying Outfit



Portable paint spraying compressor is mounted on a 2-wheel hand cart. Can be furnished with steel wheels or pneumatic tires. Gasoline engine or electric motor from 1½ hp. to 6 hp. can be mounted with it. Binks Mfg. Co., 3114-40 Carroll Ave., Chicago.

Variable-Speed Transmission

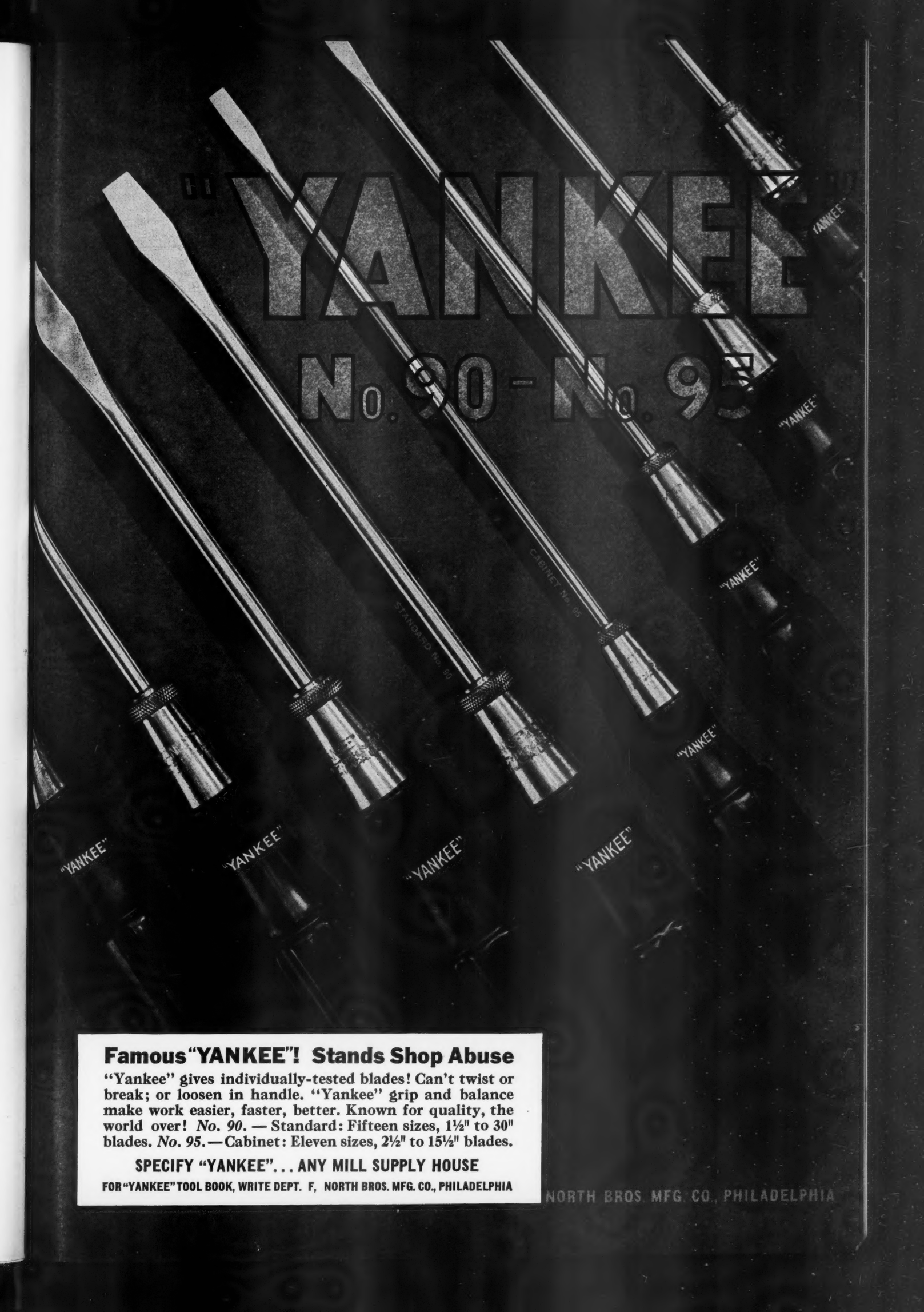
"Speed Changer Unit" is totally inclosed and has double shaft extensions driven from a standard motor to provide a flexibility that makes it adaptable to



a wide variety of layouts. Handwheel makes possible manual control. However, the unit can be equipped for electric remote control; also manual remote control. Capacities include ratings up to 33 hp. with ratios as high as 3¾ to 1. Texrope Division, Allis-Chalmers Mfg. Co., Milwaukee.

Protective Paints

"Kem-Metal" protective paints include metal primer, metal protective paints, and red lead primer. Manufacturer says they do an effective job of excluding water and gases from the metal protected. They are also said to have great durability and to improve appearance. Fast drying. "Kem-Kromik" metal primer has


"YANKEE"
No. 90 - No. 95
"YANKEE"
"YANKEE"
"YANKEE"

high inhibitive value due to balanced lead chromate formulation. "Kem Red Lead" is said to be a superior primer for this type of paint. "Kem-Elastic is finish coat for both these primers. Sherwin-Williams Co., Cleveland.

Respirator

Respirator is designed to prevent silicosis and to be worn by workers exposed to the silica dust hazard. Features compactness, light weight, unobstructed vision. Is claimed to be comfortable, so that workers will not object to wearing it. American Optical Co., Southbridge, Mass.

Pipe Connector

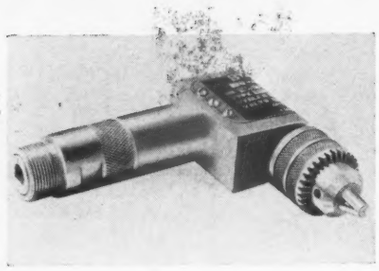
Front-drive pipe connector is a method of attaching pipe to containers without having to get on the inside. It makes it unnecessary to drain tanks to attach pipes to them. It is a one-piece unit of all-steel construction. Five standard sizes accommodate pipe sizes from ⅛ to ¾ in. Larger sizes can be had also. Multi-Seal Mfg. Co., 123 North Jefferson St., Chicago.

Wheel Puller

"Anchor" gear and wheel puller consists of three double-end chains, having a grab hook on one end for attaching to spoked wheels, and a special close-grip hook on the other end for engaging solid gears. Chains fit into the forks of a three-armed yoke, and a screw bar is threaded through the yoke. Can be used on spoked, solid, webbed, or any type or size of gear wheel, close to end of shaft or far from end. Made in 4- and 12-ton capacities. Edelblute Mfg. Co., Reynoldsville, Pa.

Hole Saw

"Pilot Hole Saw" drills round holes in all metals and other materials, with the exception of iron and steel. Will cut sheet or corrugated metal. Each cutter acts as a pilot for a cutter of larger size in the event that a hole has been drilled too small. Cutters range in size by ⅛-in. graduations from ½ to 2 in. Fray-Mershon, Inc., Glendale, Calif.



Angle Head

Series 420 close-corner angle head is designed for drilling and filing in close quarters on a flexible shaft. It is furnished with ¼-in. capacity chuck for drills, rotary files, rasps, mounted wheels, etc. Stow Mfg. Co., Inc., Binghamton, N. Y.

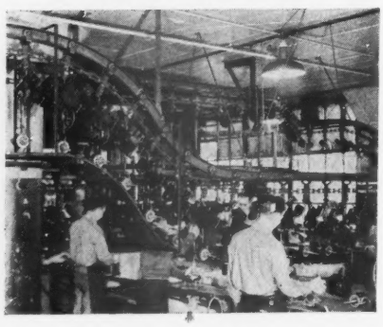
Materials Handling Pallets

Pallets for use with fork lift truck come in three styles. Design 104 is an all-steel slat-type pallet with reversible, reinforced channels. Design 101 is an all-steel, reversible, solid-type pallet with rectangular platform corrugation. Design 105 is a reversible pallet of wood-steel construction. By using these pallets it is possible to pile material in high stacks, making use of as much air space as possible. Mullins Mfg. Corp., Warren, Ohio.

Valves

Dual magnetic valve for high-low fire or flow control. Has two electrically independent solenoids operating two lever-action, high-pressure valves. Flow adjustments are provided on both ports. Valve is packless and normally closed. Energy consumption is 14 watts per solenoid. Called "General Dual K–10". General Controls Co. 450 East Ohio St., Chicago.

Overhead Trolley



Light-duty anti-friction trolley suitable for use with endless-chain, power-operated trolley conveyors, or as individual trolleys manually operated. The outer shell is made of ⅛ in. thick steel, case-hardened. Ball bearing incorporates a seal composed of a steel and felt labyrinth. Bearings are self-contained and furnished grease-packed, or without lubrication. Inner and outer ball races are of steel, three-point contact, inclosed within a steel jacket. The capacity is 150 lb. Mathews Conveyer Co., Ellwood City, Pa.

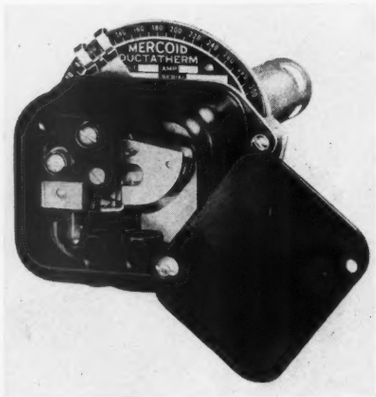
Voltage Regulator

"Silverstat" voltage regulator comes in a range of sizes for automatic voltage control of small a.c. and d.c. generators. There are no vibrating contacts. Only simple rheostat adjustments are made when putting into service, all internal adjustments being made in the factory. Direct- and quick-acting rheostatic type, it regulates voltage by varying directly the resistance in the field circuit. Completely inclosed by removable covers. Westinghouse Electric & Mfg. Co., East Pittsburgh.

Pipe Ends

"Dilecto" pipe ends are a molded laminated plastic designed to prevent dangerous grounds. They have high electrical insulating properties, mechanical strength, and are unaffected by water, steam, chemicals or chemical fumes, by high or low temperatures, it is said. Two styles: Threaded to fit standard pipe and conduit thread, or plain with three setscrews for fastening. Both types made in standard sizes from ½ to 4 in. Continental Diamond Fibre Co., Newark, Del.

Temperature Control



"Ductatherm" temperature control is designed for use in air-conditioning ducts. Can also be used for temperature control of air and gas in industrial ovens. Actuated by a small, sensitive bimetallic spiral which is located on the end of the control stem. This stem projects into the duct or chamber. Two ranges available: 50 to 300 deg. F., and 250 to 500 deg. F. Has flat mounting flange; also adjustable flange for slope mounting. The Mercoid Corp., 4201 Belmont Ave., Chicago.

Timer

Model A Interval Timer is driven by a slow-speed, self-starting synchronous motor. It has quick-make-quick-break mechanism, with silver contacts, totally inclosed. It will operate in any position. Rated at 10 amp., 120 volts, a.c., 5 amp., 220 volts, a.c., it will operate motor loads of ½ hp., heater loads of 1,200 watts, lamp loads of 1,000 watts. Available with contacts normally open, normally closed, or double-throw. Timing scales range from

THERE'S A SWITCH WE NEVER HAVE TO BOTHER WITH, JOE!
YOU SAID IT BOSS! THESE WESTINGHOUSE SAFETY SWITCHES SURE STAND UP AND TAKE IT. YOU DONT HAVE TO NURSE THEM ALONG

The exclusive Westinghouse Diamond pointed jaw confines the bead to sections outside the contact area, sections which do not normally carry current.

TIGHT, COOL CONTACTS IN THESE SAFETY SWITCHES

You don't have to keep dressing down jaws and blades to maintain tight, cool contacts in Westinghouse Safety Switches. Jaws are diamond-shaped. When contact is broken, the arc is drawn between the diamond point of the break jaw and the *end* of the blade. The sections that carry current cannot pit, bead or burn off.

In addition, one-piece copper parts prevent heating from loose connections. And in 575 and 600-volt switches, "De-ion" grids quench heavy arcs almost instantly.

For safe contact at all times, specify Westinghouse. All commercial types and ratings available from your:

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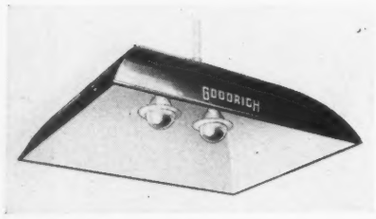
MOTORS • CONTROL • CIRCUIT BREAKERS • SAFETY SWITCHES • PUSH BUTTONS

1-min. dial with divisions in seconds up to an 8-hr. dial with 15-min. divisions. Optional feature is a delayed-start button that permits operator to set the indicator without starting the motor. Timing cycle cannot start until the delayed-start button is pressed. A second optional feature is automatic stop, for use where the same time cycle is to be repeated a number of times. R. W. Cramer & Co., Inc., 67-69 Irving Place, New York.

Lighting Fixture



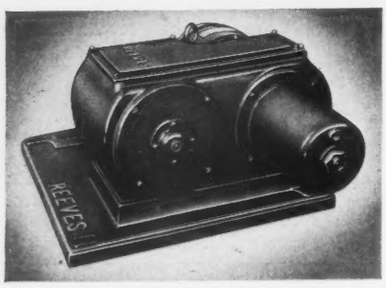
"Spraylite" produces soft shadowless illumination for close detail work. Finished in porcelain enamel. Uses bowl-silvered lamps, and all harshness is eliminated with special "no glare" louvers which fit at the lamp's bowl-silvered line. Goodrich Electric Co., 2900 North Oakley Ave., Chicago.

Respirator

Style 92 respirator is for use in lead and Type A dusts. The filter units have effective breathing area of over 45 sq. in. They are located so that they control position of the respirator on the face. The exhale valve, placed between the filter units, is up and out of the way, non-collapsible, and will not shut off when head is bent down. It has a sensitive diaphragm so that wearer can converse without removing the mask. Headband is made of gum rubber. Chicago Eye Shield Co., 2300 Warren Blvd., Chicago.

Speed Control

"Fluid Pressure Control" is an automatic remote control for use with the company's Vari-Speed Motordrive. Can be used to regulate speed automatically



from pressure variations. Complete control consists of a bellows shifting mechanism mounted on the Motordrive, an adjustable pressure-reducing valve located where desired, auxiliary valves if needed, and connecting pipes. Fluid pressure can be transmitted by oil, water, steam, gas or air. Reeves Pulley Co., Columbus, Ind.

Pipe Extractor

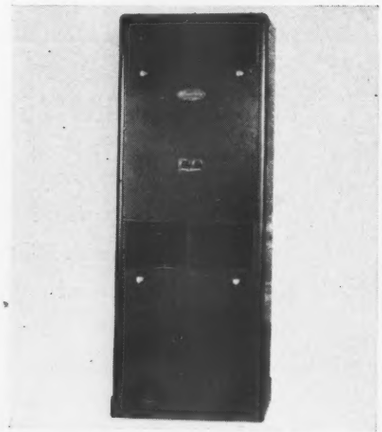
"Reps Extractor" provides means of gripping broken pipe and studs so that they can be removed. Has shallow four-point grip that provides strong bite without hammering or pounding. Extractor is inserted straight into the pipe so that all four points bite at the same time; then it is moved with a wrench in the direction of its threads. To remove studs and screws, a hole is drilled and the extractor inserted. Set of ten extractors fits pipe sizes from $\frac{1}{8}$ to 2 in. in diameter. The same set fits studs and screws from $\frac{7}{16}$ to $3\frac{1}{2}$ in. Reps Tool Co., Inc., 220 Delaware Ave., Buffalo, N. Y.

Thermometer

"G & W Compound Thermometer" is intended to be used when filling pot-heads, boxes, and cable joints with insulating compound. With this thermometer it is possible to pour the compound at the correct temperature. Thermometer is unbreakable with normal use as the stem is made of metal. G & W Electric Specialty Co., 7780 Dante Ave., Chicago.

Air Conditioning Unit

Self-contained air conditioning unit, economical in space requirements, comes in two sizes: 1,100 and 1,460 cu.ft. of air per min. The smaller is a 3-ton unit



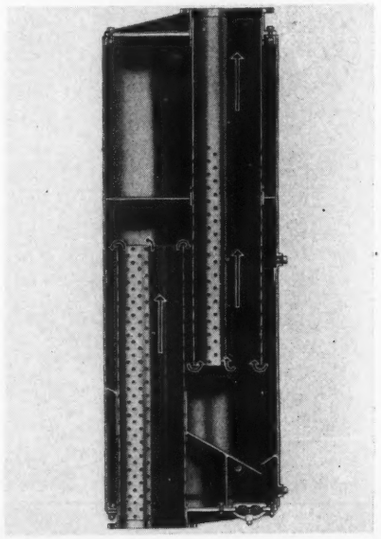
occupying only $4\frac{1}{2}$ sq.ft. of floor space. The larger is a 5-ton unit requiring 6 sq.ft. of space. These units can be placed wherever space is available as air can be discharged in any direction. Moving parts are mounted on rubber to insulate against sound. Selector and thermostat dials on cabinet front at eye level for both manual and automatic temperature regulation. Carrier Corp., Syracuse, N. Y.

Circuit Breaker

"Dublbrak" circuit breaker for 125-volt a.c. or d.c. service comes in capacities from 5 to 50 amp. This is a bimetallic, thermal-type breaker that operates similarly to an ordinary tumbler switch. It is trip free—non-closable on overloads and short circuits. Gives automatic positive protection against short circuits or sustained overloads; also has time lag characteristics that prevent needless circuit interruptions when momentary overloads occur. When circuit is interrupted, a red-dot signal button pushes out beyond the face of the unit. Frank Adam Electric Co., St. Louis, Mo.

Diesel Muffler

ATP Series spark arresting exhaust muffler for diesel engines eliminates fire hazard. It removes carbon particles and sparks of all sizes from the exhaust gases before they are discharged to the



atmosphere. Can be used both on two- and four-cycle engines without affecting their efficiency. Modified three-pass construction; the gases enter from below and exhaust at the top. If it is desired to reduce exhaust gas temperatures and to make doubly sure that all incandescent particles are extinguished, a water spray nozzle can be introduced into a pipe plug provided for that purpose. Burgess Battery Company, Acoustic Division, Dept. NR, 111 West Monroe Street, Chicago.

Lighting Transformer

Type UL transformer is designed to be mounted on a machine as an integral part, and to have its input terminals connected to the high-voltage power circuit at the motor disconnecting switch. Low voltage for lamps is then available at the output receptacle of the transformer. This makes it possible to light the work from an individual, adjustable, lighting fixture. Can be used where power circuit voltage is 115, 230, 460, or 575 volts, to supply any standard lamp voltage such as 6, 32, 64, 115. Standard sizes are rated 75, 150, 225 and 300 watts output. American Transformer Co., 178 Emmet St., Newark, N. J.

Controller

"Micromax Pneumatic Control" moves final control valve both as function of temperature change and function of how long and how far temperature is off the control point. Uses two balances—an

IT COSTS *LESS* TO BE MODERN

TOO OLD-FASHIONED

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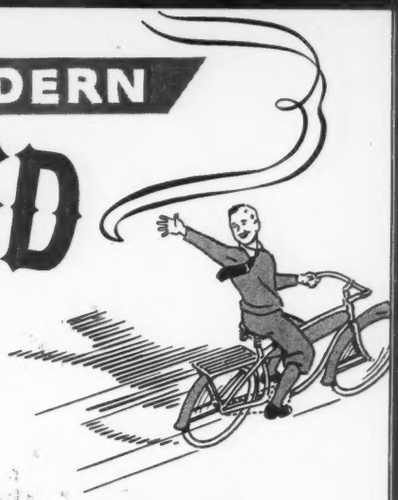


Today's fast production pace calls for efficient handling of bulk materials with up-to-date equipment, such as REDLER Conveyor-Elevators.

ONE REDLER CONVEYOR-ELEVATOR CONVEYS COAL, CHEMICALS, GRAIN, FOODS IN ANY DIRECTION

REDLER Conveyor-Elevators are dust-tight, and convey practically any pulverized, granular and small lump material *in any direction.*

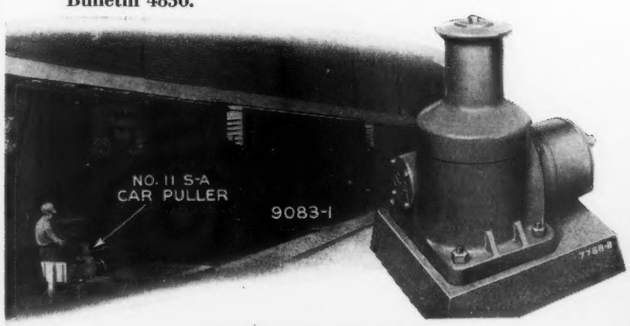
They require only ¼ to ½ the space conventional units need, and are low in both first and maintenance costs.

Investigate REDLER Conveyor-Elevators now!

ASK FOR REDLER CATALOG 42!

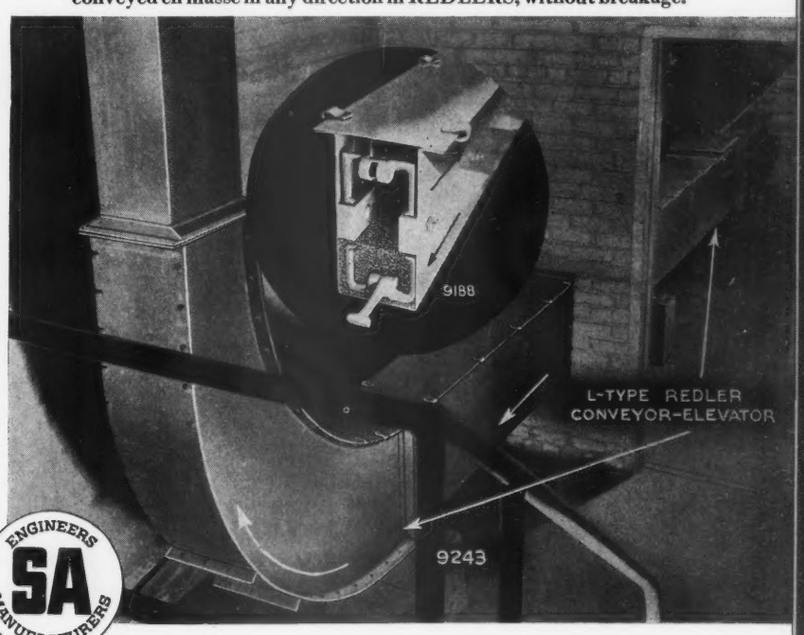
SPOT UP TO SIX LOADED CARS

The compact No. 11 or No. 12 S-A Car Puller is the low cost answer to your Car Spotting problems. Write for Bulletin 4836.



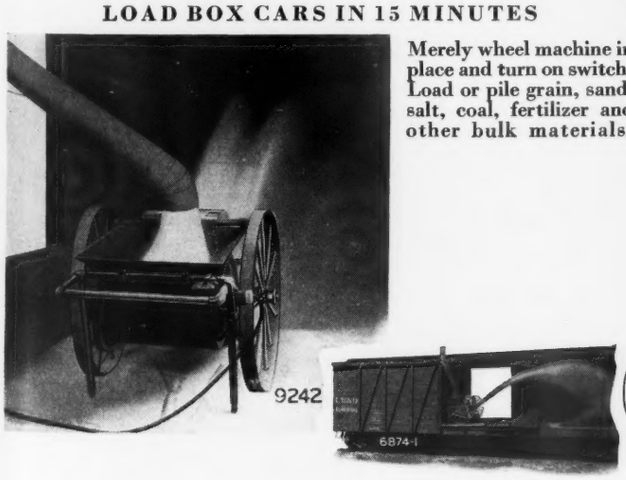
CONVEY-ELEVATE WITHOUT BREAKAGE IN COMPACT REDLER CONVEYOR-ELEVATORS

This L-type REDLER both conveys and elevates coal from track hopper to overhead bunkers. Other pulverized, granular and small lump materials including grain, chemicals, cement and foods are conveyed en masse in any direction in REDLERS, without breakage.



LOAD BOX CARS IN 15 MINUTES

Merely wheel machine in place and turn on switch. Load or pile grain, sand, salt, coal, fertilizer and other bulk materials.



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Hand and Motor Winches
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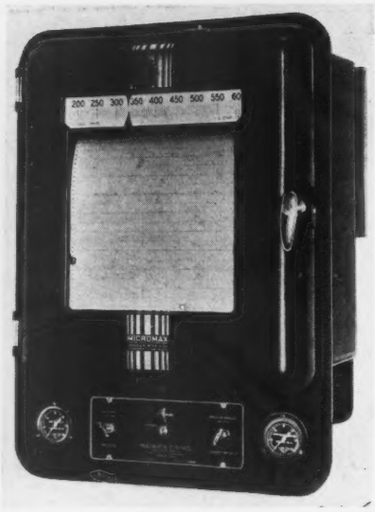


electric balance for measurement, a pneumatic balance for control. A lever in front of instrument panel gives change at will from manual to automatic control. For accessibility, full instrument swings out of the case. Leeds and Northrup Co., 4901 Stenton Avenue, Philadelphia.

Torch Cutting Machine

"Hayes Torch Machine" is a pantograph cutting machine arranged with a tracing wheel to follow the contour of any templet or the lines of any drawing. Power to move the tracing wheel is provided by a motor using ordinary lighting circuit current. Carrying arrangement for the torch allows the torch to be moved up and down and also slanted for cutting a bevel. Tracing wheel and torch are arranged to run at speeds of approximately 5, 10, 16 and 24 in. per min. Hayes Track Appliance Co., Richmond, Ind.

Belt Vulcanizer

The 48–60 Combination Vulcanizer will vulcanize belts up to 60 in. in width. Platens are 65½ in. wide and 12 in. long. Rectangular in shape, they can be placed at a 10-deg. angle on a 60-in. belt, 22-deg. angle on a 54-in. belt, and a 30-deg. angle on a 48-in. belt. Can be furnished in either 110 or 220 volts. Mechanical Rubber Goods Division, The B. F. Goodrich Co., Akron, Ohio.

Motor

High-torque, double-capacitor motor. Designated as Type RZN when equipped with rigid mountings and Type RZNR when equipped with annular resilient mountings. Available in ratings of ⅓, ½, ¾ and 1 hp. for 110/220 volts. Two condensers of different values—high value of capacitance for starting and low value for running. Change in capacitance occurs at approximately 75 per cent full load speed by means of a centrifugal switch located on the motor. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.

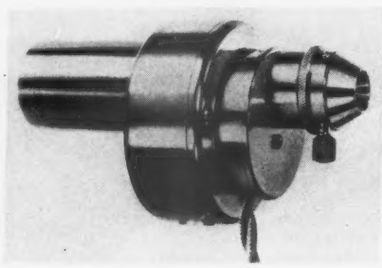
Switch

Mercury plunger relay switch has only one moving part and is said to be without a.c. hum or chatter. Rated 30 amp. or 1 hp. a.c. Plunger within glass tube is pulled down when coil is energized. This action displaces mercury in the tube and floods the contact, which closes the circuit. Closing and opening is said to take place at high speed. H-B Electric Co., Inc., 2518 North Broad St., Philadelphia.

Scale Truck

Sensitive beam scale has been incorporated on lift truck. Scale capacity is 1,000 lb. Lift is compounded so that a single stroke raises the load. Ball-bearing, rubber-tired wheels for easy pulling and absorbing jars dangerous to the scale mechanism. Design will be furnished in greater capacities. Called "Blue Streak." The Yale & Towne Mfg. Co., 4530 Tacony St., Philadelphia.

Pyrometer



"Ardometer" radiation pyrometer measures surface temperature of hot objects or masses above 1,000 deg. F. Temperature is recorded on one of the company's potentiometers, on a round- or strip-chart recorder, or a millivoltmeter pyrometer. This instrument can be sighted directly on objects in the furnace and in this position it measures instantly the temperature of the object itself. The Bristol Co., Waterbury, Conn.

Wire Stripper

Brush-type wire stripper strips cotton, silk, enamel, string asbestos covered wire, and removes gummy insulation embedded in stranded wires. Will strip rectangular or square conductors. Driven by ¼-hp. motor. Heavy metal guards in front of revolving wire brushes and over driving belts protect operator's fingers. Thumb adjustment screw varies the distance between brushes for various sizes of wire, while an adjustable stop behind the brushes fixes the length of stripping. Operates on 110-volt. 60-cycle circuit. Ideal Commutator Dresser Co., 1416 Park Ave., Sycamore, Ill.

Mop Wringer

"Super-wringer" is designed for heavy-duty work and will take care of mops up to 36-oz. size. Operated by a handle that is pushed down to wring mop; when released, dry mop can be removed. Water is squeezed downward into container preventing splash. Wringer fits any round or square container. All parts are rustproof. All joints are welded and said to be impervious to cleaning compounds, soap, and water. Geerpres Wringer, Inc., Muskegon, Mich.

Arc Welders

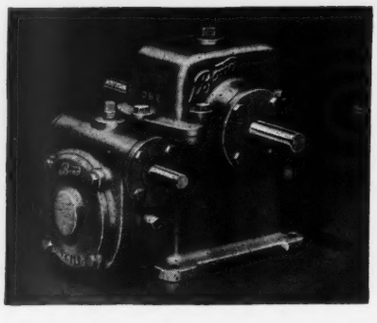
Improved line of "Multi-Range" arc welders is divided into ten ranges with a 100-step rheostat operating in each range. Operation is claimed to be smooth and free of "dead spots". Remote control feature is located within ten-range dial where it automatically plugs in or out when used on the machine or at any distance away. With a lamp cord extension the volt-amp. adjuster can be set close to the hand of the operator, wherever he may be working. "Junior" models with built-in electric motors come in 100- and 150-amp. ratings, or with self-starting gasoline engine at 200-amp. ratings. "Senior" models range from 150 to 600 amp. with electric or gasoline-engine drive. Hobart Brothers, Troy, Ohio.

Caster Wheel

"Doenut" caster wheel has a tire 12 in. high and 3.30 in. in diameter. Total overall height from floor to top of plate is 14 in. Top plate is 7x4 in. and operates with a ring of ball bearings for easy turning. Wheel is double-disk type and engineered for loads up to 325 lb. per wheel. Musselman Products Co., 6276 St. Clair Ave., Cleveland.

Speed Reducers

Type B double-reduction speed reducers are capable of handling inputs up to 2 hp. Ratios as high as 4,000 to 1 are available in both horizontal and vertical types. Worm gears of bronze and worms



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- PROTECT LIFE AND PROPERTY—Use Master Explosion Proof Motors in presence of explosive gas or dust.
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- FAN COOLED for cool operation and long life.
- GEARHEAD EXPLOSION PROOF MOTORS available with Underwriters Laboratories approval nameplate.
- A COMPLETE LINE—1/8 to 75 Horsepower.

THE MASTER ELECTRIC COMPANY, DAYTON, OHIO

of hardened steel are used in these units. All shafts are mounted on bearings and oils seals are used on all shaft openings in the housings. Charles Bond Co., 617 Arch St., Philadelphia.

Respirator

No. 7 respirator is a twin-cartridge type easy to put on and adjust. It employs two filter cartridges to give it easy breathing qualities. Fits face with fume-tight seal. Binks Mfg. Co., 3114-40 Carroll Ave., Chicago.

Truck

"Floormaster" truck has arc welded frame with double side girders that hold the hardwood top in place with a vise-like grip, eliminating use of bolts. T-type steel end protection saves top wood from being chewed through rough usage. Casters are hung on four steel arch sections. The main wheels are suspended on a bridge-type hanger. Roller bearings are used in all wheels. Metal, solid-rubber, or pneumatic tires are available. Standard capacities range from 1,000 to 4,000 lb. Lewis-Shepard Co., 245 Walnut St., Watertown, Boston, Mass.

Insulating Cement

No. 1 insulating cement is said to be effective up to 1,800 deg. F. with a low heat-loss factor. Can be used on boilers, drums, walls, ducts, valves, breechings, flanges, and similar hot equipment. Applied on a clean surface, it adheres immediately, forming a continuous blanket of insulation without joints, and strengthens considerably upon drying. Requires no skilled labor for application and is reclaimable when equipment is replaced. Baldwin-Hill Co., 502 Klagg Ave., Trenton, N. J.

Pumps

Types J and K non-clogging centrifugal pumps are adapted for handling process fluids, food products, wastes and sewage. Built for both horizontal- and vertical-drive installation. Cast iron alloy impeller with two streamlined blades is of the side-suction, inclosed type. Casing is made of high-tensile-strength alloyed cast iron. Stuffing box is a separate casting bolted to the casing and is extra deep to receive a minimum of six rings of packing. Water seal ring is provided with tapped opening for connection to clear water when handling abrasive materials. Heavy-duty, double-row, grease-lubricated ball bearings are contained in dust- and splash-proof housings. Gardner-Denver Co., Quincy, Ill.

Hollow Screw Wrenches

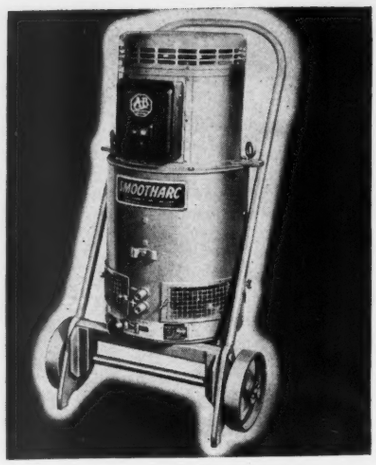
Line of wrenches for hollow screws contains interlocking drivers, handles, extensions, and ratchets so that user can assemble a tool of size, shape, and length needed. This wrench resembles a detachable head of a socket wrench, but in place of a socket to fit over a screw head, it has a protruding hexagonal driver that fits into the hollow screw. Ten sizes fit all hex nut hollow screws and cap screws from ¼- to 1-in. diameter. Wrenches, handles, and extensions are made of chrome-vanadium steel. Reversible ratchets are drop forged with hardened steel gears. All wrenches and parts are chrome plated. Armstrong Bros. Tool Co., 317-357 North Francisco Ave., Chicago.

Thermometers

Line of indicating, resistance thermometers for air conditioning and general industrial application where regular temperature readings are wanted in rooms, air ducts, etc. Temperature range from —30 to +250 deg. F. Made in several models, they may be equipped with multiple switch for connecting up to 21 temperature bulbs located at different points. Wheelco Instruments Co., 1933 South Halsted St., Chicago.

Arc Welder

This 150-amp., vertical-type arc welder can be used in welding both ferrous and non-ferrous metals in the lighter gages. Plug-in-type table receptacles for easy current reversing. Furnished in a.c. drive only, it is said to have current of high uniformity. Towing handle provides easy movement around the shop and stability



when raised to form a 3-point base. Ventilation is provided through pressure intake at the top and exhaust at the bottom. Harnischfeger Corp., 4400 West National Ave., Milwaukee.

Sliding Grill

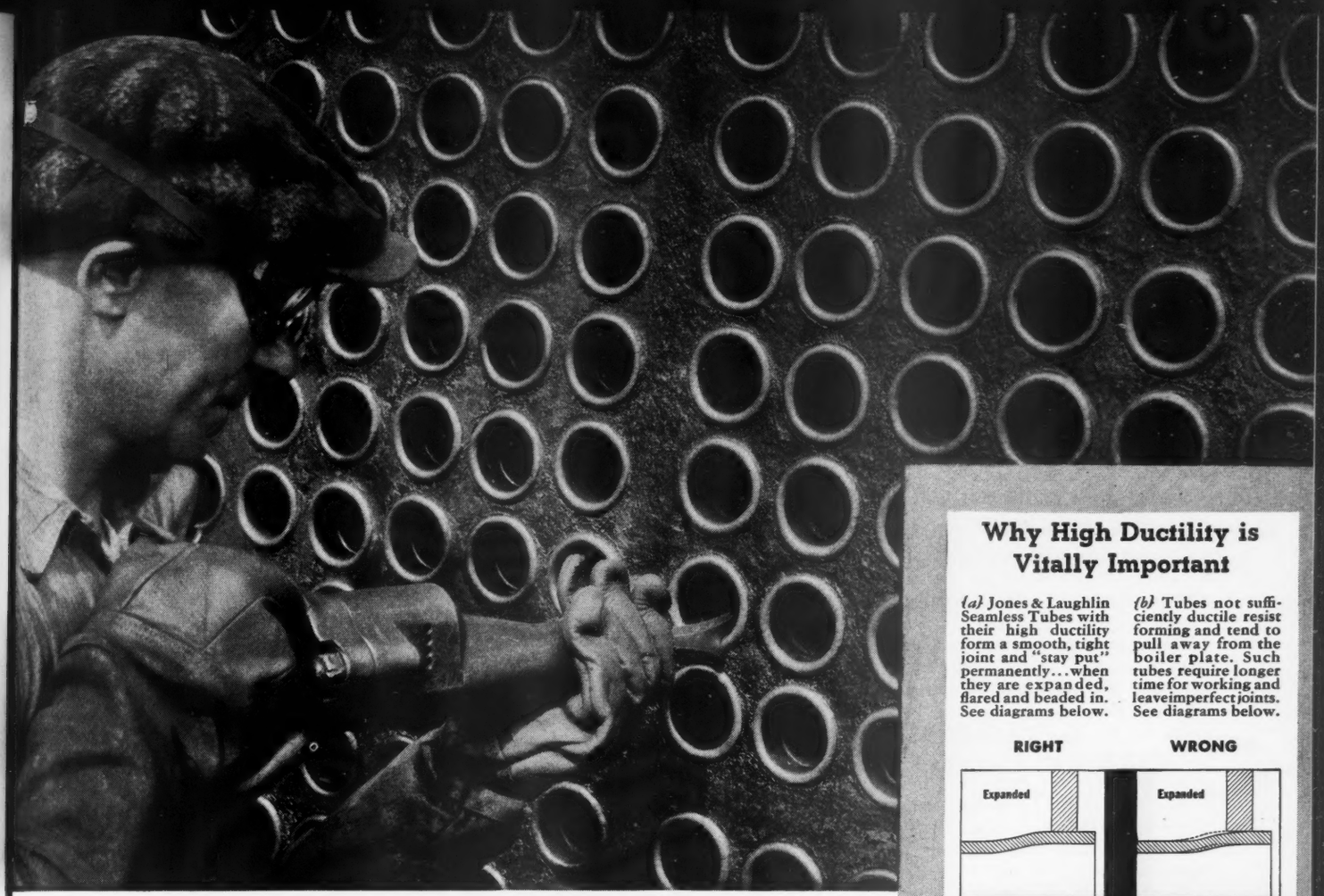
"Sliding Grill" is a flexible steel curtain hung from an overhead track. Made of heavy, galvanized, chain-link mesh it is extended to any height of opening by galvanized vertical rods running to the supporting track above. To open, it slides to one side and nests in less than one-sixth of the opening width. Can be made to travel around a curve and lie at a right angle to the opening. A bottom track can be furnished if desired. The structure can also be made in aluminum or stainless steel. Cornell Iron Works, Inc., 36th Ave. and 13th St., Long Island City, N. Y.

Variable-Speed Pulley

Variable-speed motor pulley fits shaft of standard motor and drives directly to a pulley or sheave on the driven shaft. Motor and pulley mount on an adjustable base which permits infinite variation of speed of the driven shaft. Lewellen Mfg. Co., Columbus, Ind.

Goggles

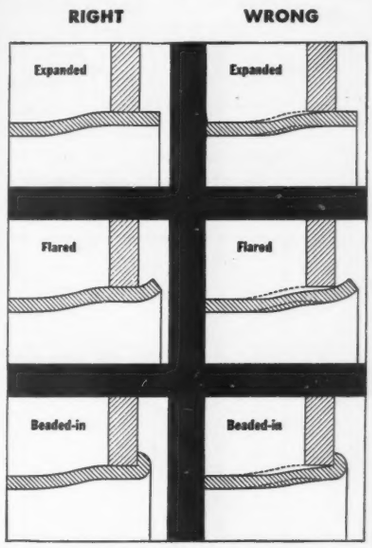
Style WVI spectacle goggle is designed for industries where falling or flying objects present an eye hazard. Equipped with Super-Tough lenses which are wide and give full view. Available with wire screen, leather, or transparent composition side shields. Willson Products, Inc., 242 Thorn St., Reading, Pa.



Why High Ductility is Vitally Important

(a) Jones & Laughlin Seamless Tubes with their high ductility form a smooth, tight joint and "stay put" permanently...when they are expanded, flared and beaded in. See diagrams below.

(b) Tubes not sufficiently ductile resist forming and tend to pull away from the boiler plate. Such tubes require longer time for working and leaveimperfectjoints. See diagrams below.



J & L manufactures a complete line of seamless and welded steel tubular products. This includes seamless pressure tubes, condenser and heat exchanger tubes.

• • •

Flange steel plates and firebox steel.

Here is why you get QUICK, easy installation, longer life and greater safety with

J&L SEAMLESS STEEL BOILER TUBES

When boilers get the shut-down habit, Jones & Laughlin Seamless Steel Boiler Tubes will help you get them back on the job in a hurry. J & L Tubes roll in faster and then stay put. They keep your boilers working efficiently and economically because every length of J & L Boiler Tubes has built into it an extra margin of strength, safety and high ductility.

The exclusive method by which Jones & Laughlin Tubes are manufactured is responsible for their time and money-saving features. Every tube is rolled from a solid billet of selected steel. There are no welds — therefore, no weak spots where a rupture can start.

This strength and durability built into Jones & Laughlin Tubes mean that boilers equipped with them stay on the job longer and with fewer costly shut-downs.

The next time you need boiler tubes, call your Jones & Laughlin Boiler Tube distributor. You will get tubes which give you low installation cost . . . which last longer . . . and you will get them quickly.

JONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS
PITTSBURGH, PENNSYLVANIA

MAKERS OF HIGH QUALITY IRON AND STEEL PRODUCTS SINCE 1850

J & L—ALWAYS MAKING FINER CARBON STEEL PRODUCTS FOR NEW AND BETTER USES

Operating Shorts

Built-Up Crates Save Space, Cut Trucking Cost

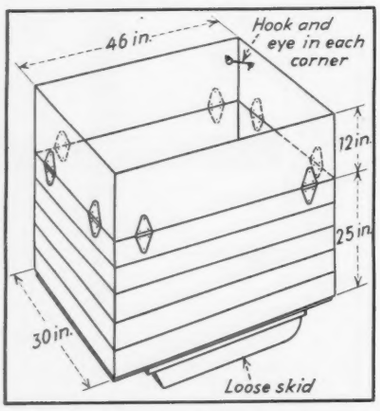
E. C. SCHLENKER
Colonial Radio Corporation, Buffalo

Our plant recently was confronted with a common problem in the storage and transportation of parts in process, for which an unusual but simple solution was found.

We have a number of crates or large tote boxes, 30 in. wide, 48 in. long, and 25 in. deep, which are used with the conventional loose skid beneath for handling sheet-metal parts.

It was first assumed that the logical procedure was to build additional crates and skids to match, but a check-up of the floor space for storage showed that this solution was impracticable.

Eventually it was decided to build the crates up on all four sides with



1-in. boards 12 in. wide, each fastened to the crate with two hinges. A hook and eye was put in each corner. This method of construction has an advantage over a solid, built-up crate because the sides can be dropped outward and down without any danger of the boards being lost.

Now when a crate is filled to the former 25-in. height the extension boards are raised and hooked in position. Adding these boards has increased the capacity nearly 50 per cent, without increasing the floor storage space required. As the next operator empties the crate one or all of the sides can be lowered to enable him to reach parts near the bottom.

Since the cost of transporting a crate was not increased, the trucking cost per 100 pieces has been lowered 32 per cent.

Good replacement for a broken ladder rung is a length of pipe, supported by a long bolt that passes through ladder sides, the pipe, and four washers, and is held on by a nut.

Better Lighting Makes Pump Maintenance Easier

ELTON STERRETT, *Longview, Tex.*

Originally the lighting fixtures for a transfer pump room handling gasolines and light oils were installed on short drops from the roof trusses. In addition, the dado or "finger print" section of the wall was a little above the window level all around, although the pumps were set in a pit.

Since this arrangement was not satisfactory from the standpoint of adequate illumination, it was improved by running a conduit line across the fireproof wall which divides the pumps from the motors and placing a fixture directly above each pump unit. As shown, the sockets and reflectors are carried on gooseneck brackets supported near the top of the bend by a wire running to an expansion eyelet higher up in the wall.

This change resulted in double the illumination and has made inspection of the pumps a simple matter of going along the cat-walk, whereas the former procedure was to step around each pump in order to check the packing and glands.

Further improvement in the lighting was obtained by carrying the white paint down on the firewall to a height above the floor which corresponds to the height above the catwalk on the other side. This lowering of the black line gives ample paint reflecting surface to provide adequate working light below the catwalk for checking the valves and flow lines, and thus has eliminated all need for a portable light when maintenance work is being done.

•

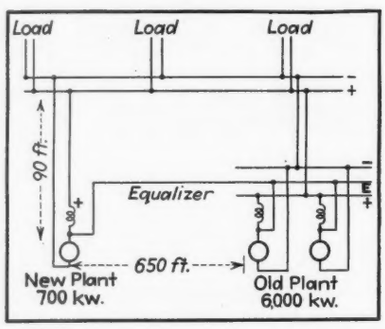
No Equalizer Needed With These D.C. Generators

J. DIXON, *New York*

A large, isolated plant required additional generating capacity, and because space was lacking in the engine room it was decided to locate a new, 700-kw., d.c. unit in a building 650 ft. distant and operate it in parallel with the main 6,000-kw. plant.

When operation was started the new diesel-engine-driven unit acted in an unexpected manner. After running for hours without difficulty it would apparently lose part of its voltage and trip off, due to reverse current.

During a careful investigation the current flowing in the equalizer was measured. It was found to vary considerably without visible reason, flowing sometimes in one direction and sometimes in the other.



Examination of the connections disclosed that the mains from the new unit did not run back to the old bus, but were tapped onto a large feeder at a point near the new unit. The equalizer, however, ran directly from the new unit to the equalizer bus in the old plant. Since the equalizer was in parallel with the feeder the current flowing in it was affected by the load drop in the feeder.

When the new unit was operated with the equalizer disconnected, the trouble disappeared.

Operation of flat-compounded, or even slightly over-compounded, gen-

(Continued on page 108)

Bassick TRUCK CASTERS

The complete line . . . with sizes and types for every materials-handling requirement

Outstanding leadership in volume of business—resulting from leadership in

- **Engineering development**
- **Quality of product**
- **Economy in cost**
- **Economy in operation**

When you need truck casters or casters of any size, any type, for any purpose, think of *Bassick*—and let a conveniently located industrial distributor of Bassick Casters check your requirements. Factory representatives are also at your service. Ask for Bassick Catalog No. 120.

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AMERICA'S FIRST WIRE FENCE • SINCE 1883

(Continued from page 104)

erators in parallel without equalizers is common in steel mills and other plants that cover a wide area. If the generating points are so far apart that the line resistance acts as a ballast, no difficulty is encountered.

With the installation described, if other units are installed close to the new one they should be equalized with it in the usual way, just as the units in the main plant are equalized. However, an equalizer connection between the two generating plants as they are now arranged is not only unnecessary, but definitely objectionable.

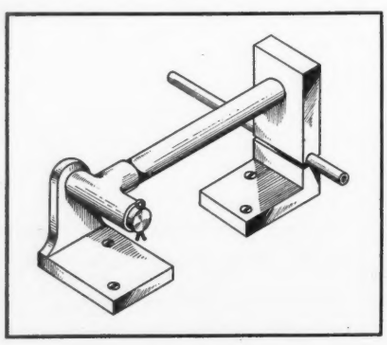
Service records of materials used will show definitely which give most economical service, eliminate faulty judgment.

Bench Hammer Straightens Tubing

L. KASPER, *Philadelphia*

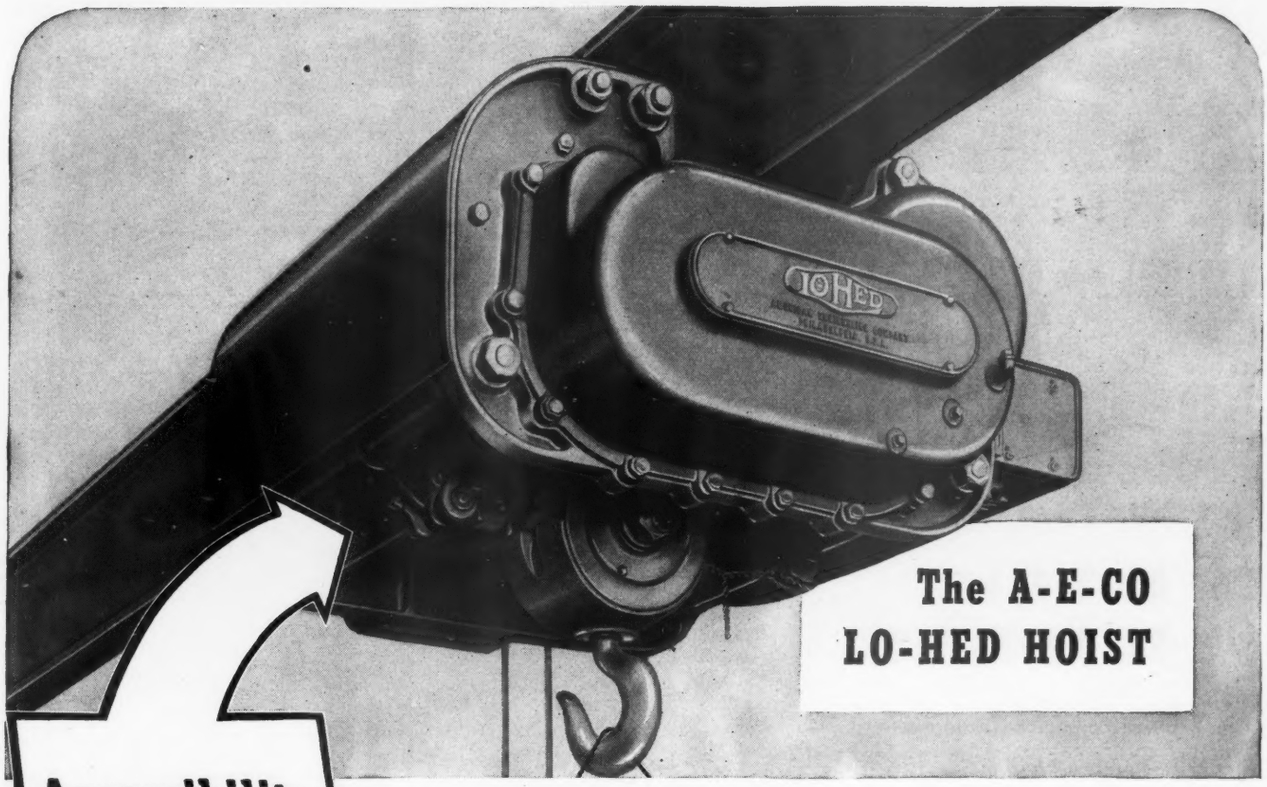
A number of pieces of tubing had to be straightened. The number was not great enough to warrant construction of expensive equipment, but it was necessary to straighten them quickly and without marking. All attempts at straightening with a hand hammer resulted in crushing or marking the tubing. The bench hammer shown in the sketch was made, and served the purpose perfectly.

The handle of the hammer is a piece of pipe, threaded into the head



at one end and into a pipe tee at the other, the three pieces being brazed together. Support for the hammer is made of a piece of angle iron, into which a pin is brazed. The grooved working face of the hammer head is made slightly convex while the grooved face of the anvil is made slightly concave, so that the force of the blow springs or sets the tubing slightly.

With this type of hammer, it is im-

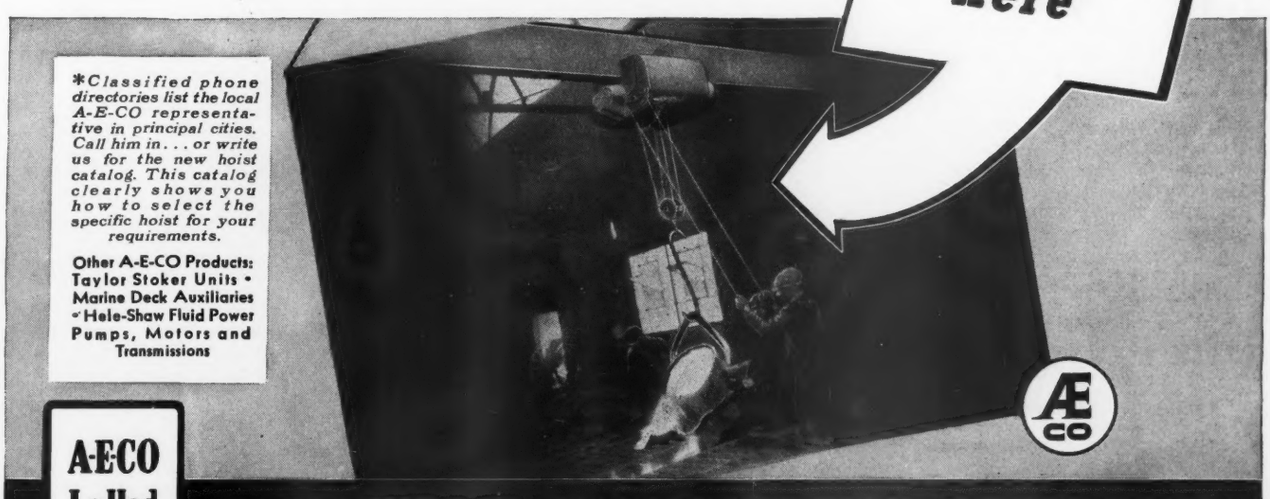


The A-E-CO LO-HED HOIST

Accessibility of Working Parts Here

Select THE hoist with the greatest accessibility of working parts. Ask the nearest A-E-CO representative* to show you how quickly the working parts can be reached if repairs are required. Ask him to explain Lo-Hed's exclusive features that mean dependable performance and lower maintenance cost. Let him show you Lo-Hed's uses in scores of industries. Find out *why* Lo-Hed is the logical hoist for EVERY purpose and why it is the *only* hoist for low headroom conditions. A-E-CO Lo-Hed HOISTS are built in 98 standard models—from ¼ to 12 ton capacities.

Reduces Handling Delays Here



*Classified phone directories list the local A-E-CO representative in principal cities. Call him in . . . or write us for the new hoist catalog. This catalog clearly shows you how to select the specific hoist for your requirements.

Other A-E-CO Products:
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A-E-CO Lo-Hed HOIST

AMERICAN ENGINEERING COMPANY

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SALE

CLEAN HANDS
AT
LOWEST COST

A Single Onliwon Does the Work of Several Ordinary Paper Towels

Onliwon Towels are the simplest and most economical solution of the "fingerprint" problem. Onliwon Towel Cabinets and Onliwon Towels, properly located throughout your plant as well as in your washrooms, make "clean hands" easier.

Employees appreciate the convenience and cleanliness of the Onliwon system and washrooms look neat and *stay* neat longer.

And Onliwon Towels help check the spread of disease. The cabinet *locks out* dust and dirt; prevents careless handling. Every one gets a fresh, *individual,* cloth-like towel every time.

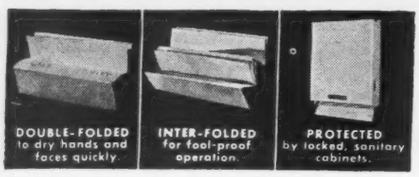
If you consider price alone, you're apt to get towels that *won't dry.* But Onliwon Towels have extra size, absorbency, and strength, so it takes just one to give a quick, thorough dry. To make sure you get the most for your money, Onliwon Towels are dispensed, one-at-a-time from locked cabinets.

Before you buy more towels, be sure to find out about Onliwon's money-saving, health-guarding advantages. Telephone your local A. P. W. distributor, or write to: A. P. W. Paper Co., Albany, N. Y.

A.P.W.

Onliwon Towels

PREVENT "WASHROOM INFECTION"


DOUBLE-FOLDED to dry hands and faces quickly.
INTER-FOLDED for fool-proof operation.
PROTECTED by locked, sanitary cabinets.

possible for the user to strike a foul blow, and it is less fatiguing to use than a hand hammer.

•

It's Quicker to Stencil

JOHN F. PIERCE
Director, Office Service Department
Tennessee Valley Authority

One of our engineers has to handle a great many photographs. As it was necessary to file them for future reference, the name or code number and other requisite data were typed across the backs. It was found, however,

that a stencil and a half-roll stamp would do the job faster and more economically. Not only that, but sometimes the typing used to show through on the photographs—an especially bad feature if they were ever used for reproduction purposes. The stencil is the same kind that is used on a mimeograph machine, and is cut to fit the stamp.

•

An Idea to Prompt Ideas

The coin illustrated was given to each of the 250 men taking the Work Simplification Course at the plant of the Winchester Repeating Arms Company, New Haven.

Decision to make and distribute the coin was the result of two related requirements. Thomas I. S. Boak, Works Manager, wanted something to stimulate people to keep the objectives of the course

For Better Service—
INSTALL TRICO
REG. U.S. PAT. OFF.

TRICO PRODUCTS have always been built to give the ultimate user a lasting money-saving investment. Today those who know, say: "*If it's TRICO—it's good.*"

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With the famous powder-packed element
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"America's Assistant of plug fuses"
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Lock fuses and clips together
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For heavy duty testing
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For safe handling of fuses
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For motors, line shafts, etc.

New TRICO FOLDER CPF-300 gives complete details and valuable information. Send for your copy TODAY!

TRICO FUSE MFG. CO., MILWAUKEE, WIS. U. S. A.
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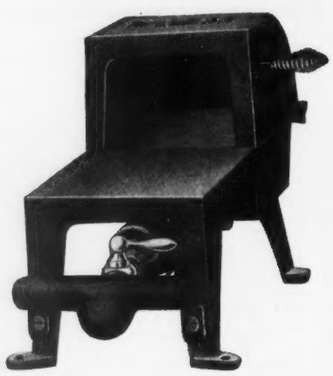
STOP WASTED KILOWATTS AND WASTEFUL SHUTDOWNS

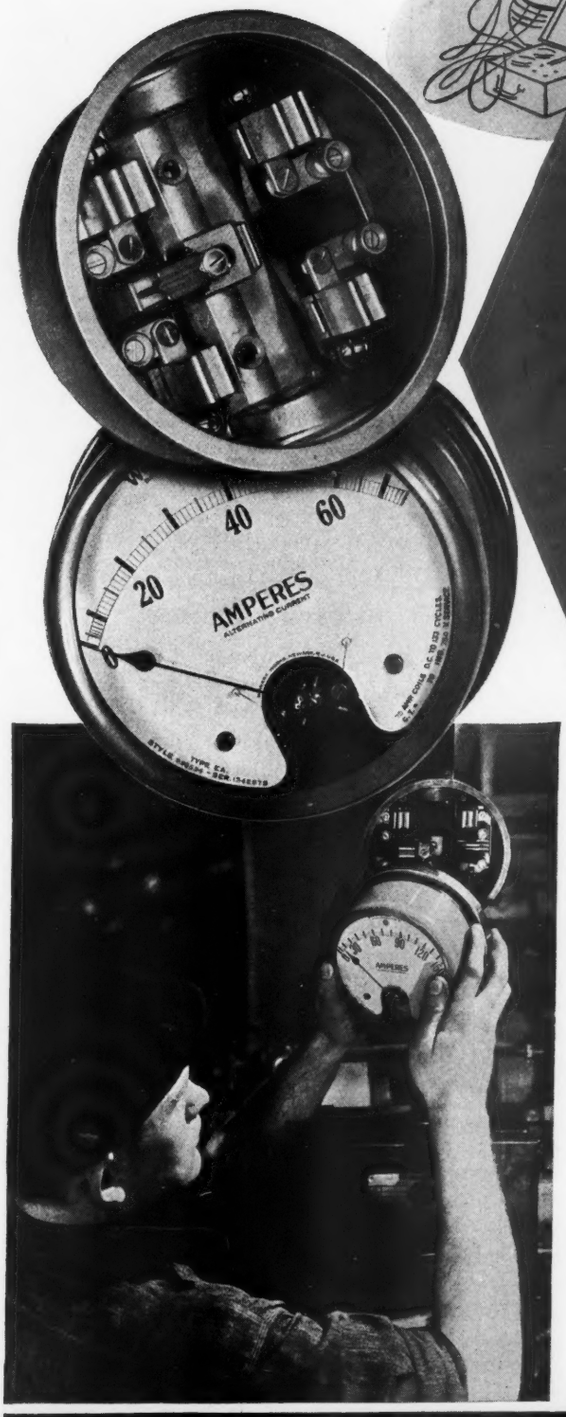
A JOHNSON No. 501
SOLDERING FURNACE
Will Reduce Your Costs



This sturdy cast iron Bench Furnace will heat soldering coppers up to six pounds per pair, and do heating work and metal melting. The famous Johnson Direct Jet Bunson Burner, with shut-off valve and pilot light, gives intense heat at low cost. The fire box base is refractory lined, and a special shelf protects the points of coppers. Write today for free catalog on the complete line of economical Johnson Gas Appliances.

JOHNSON GAS APPLIANCE CO.
Cedar Rapids IOWA

DON'T STOP PRODUCTION TO GET TEST DATA...



Install THIS WESTINGHOUSE INSTRUMENT SOCKET...

No longer need you shut down machines in order to make tests on motors or electrical circuits!

Simply by installing Type "S" Sockets in the conduit on your electrical circuits, you can gain *instant* access to vital power and machine performance facts with Westinghouse Socket Instruments. Just remove the socket cover plate, plug in the desired instrument and start taking readings — *in a minute or less.*

Type "S" Sockets, available for as little as $1.85 each, are quickly installed — no special mounting or expensive accessories required. Start now to benefit from this new, convenient, economical method of using instruments. Send today for complete information. Westinghouse Electric & Mfg. Company, Dept. 7N, E. Pittsburgh, Pa.

Send for Booklet B-2136 — explaining how to get instant access to vital operating facts at lower cost than ever before. Complete line of instruments available.

J-40146

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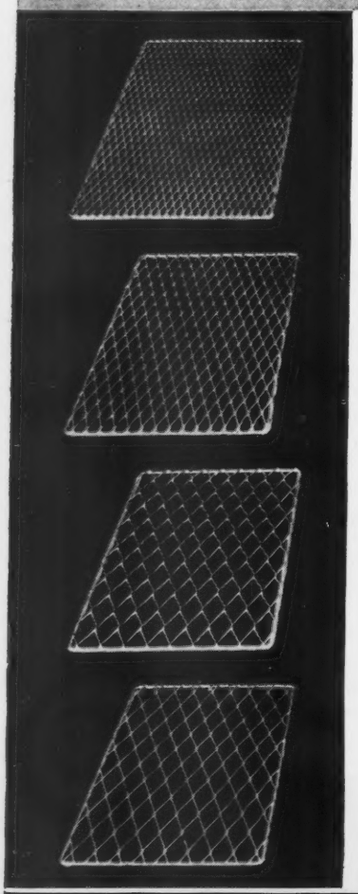
Westinghouse

ELECTRICAL INSTRUMENTS

"The Standard of Accuracy Since 1888"

Steelcrete *Expanded Metal*
SHELVES AND SHELVING



Solve the Storage Problem!

● In your storerooms, shipping department—wherever materials, parts, or products must be stored, bins and racks of Steelcrete Expanded Metal will solve the problem at a worth while saving. Steelcrete Expanded Metal is free from burrs and sharp edges. Expanded from a solid sheet of steel, it provides maximum rigidity and strength. Its strands cannot unravel or separate. This strong, safe fabric is available in large flat sheets with the necessary framing materials and fittings for those who prefer to make their own storage units. Complete units custom made at a nearby Steelcrete shop can also be supplied. Steelcrete Expanded Metal shelves for use in display racks, refrigerators, show cases, furnaces and oven trays and other equipment can be supplied to specifications either in the standard expanded mesh or flattened Expanded Metal with smooth surfaces. Write for the Steelcrete handbook covering many uses of Expanded Metal. Also ask about Steelcrete industrial fence made of Expanded Metal.

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in mind. The company had just purchased a coining press, and the head diemaker wanted to try it out. So the coin was designed to do both jobs. It is not the same size as any U. S. currency and will not operate slot machines and turnstiles.

The extent to which the coin has been effective in stimulating ideas is not known, but the results of the work simplification course have been gratifying. A great many worthwhile suggestions, covering every phase of plant activity, have come forth.

Where a product coming off rollers at high speed is likely to buckle and cause a jam, a mercury-contact tube attached to a lever resting on the material will detect the first signs of buckling, stop the motor operating the rollers.

It Took One Exciter to Excite Another

G. B. Thompson, *Chief Operator*
Windpass Gold Mining Company
Little Fort, B. C., Canada

Keeping the diesel-electric plant of a gold mine in the interior of British Columbia in continuous operation presents many problems to tax the ingenuity of the engineer in charge, particularly when that plant is situated some distance away from even a machine shop. Here is how one problem was solved:

In this plant there are three 2,300-volt alternators, each excited separately by its own machine. There is no provision for parallel operation of the exciters. One of these units, a shunt-wound machine with commutating poles, suddenly failed to generate. No defects could be found with the simple testing equipment available, but the machine simply would not pick up voltage.

On the assumption that the trouble might be due to lack of residual magnetism, jumpers were run from the field circuit of this machine to the armature circuit of a second exciter, so that full potential could be put across the shunt field. This expedient solved the difficulty, and the exciter came up to full voltage as soon as some of the field resistance was cut out. The machines were run with this hook-up until a smaller pulley was obtained, to drive the exciter at a higher speed.

The only objectionable feature of this connection lay in the fact that

CRANE PLUG DISC VALVES

FOR HEAVY-DUTY INDUSTRIAL SERVICE

● At a pressure of 300 lbs. and a temperature up around 550° F., steam can make short work of a valve that must be operated partly open—unless that valve is designed specifically to meet all those conditions. For this strenuous service, Crane will back its No. 382P Plug Disc Valve against the field. Here's the sturdiness to stand up, month in and month out, under the abuse of running steam continuously through a valve in throttling service. Here's the combination of design and materials that means faithful performance and a tight, sure seat, in service involving frequent opening and closing. Why? It's what's inside these 382P's that counts. It's the right mixture of brains and metals—backed by Crane's 80 years of knowing how to build valves right—checked by every test the Crane laboratories could devise—and proved by the experience of users everywhere. It will pay you to look "inside" a Crane 382P valve, see for yourself why its design is right and its metals chosen to resist *every* condition of use. "The Inside Story of Crane Plug Disc Brass Valves" tells you in a few, full-of-fact pages how Crane designs and builds these valves to give you uncommon service. Send for a copy today.

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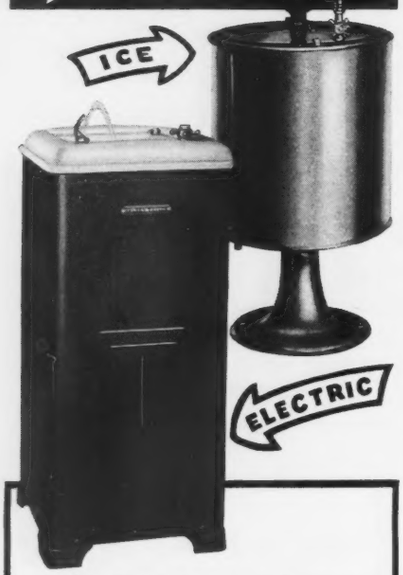
NATION-WIDE SERVICE THROUGH 134 BRANCHES AND MORE THAN 500 WHOLESALERS

The No. 382P—one of the 15 types of Crane's brass plug disc valves

IT'S WHAT'S INSIDE THAT COUNTS!

ELECTRIC or ICE COOLERS by Halsey Taylor



• Models to meet your particular needs

Halsey Taylor Coolers, either electric or ice, have a background of years of specialized experience in the manufacture of sanitary drinking fountains. Only Halsey Taylor provides the advantages of patented hygienic features, trouble-proof mechanical construction and minimum maintenance costs!

Electric models, air or water-cooled, 4 to 16 gal. per hour Ice Coolers— 80-lb. and 120-lb. capacities.

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WARREN • OHIO.

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Exclusive Features:
Two-Stream Projector
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The Halsey W. Taylor Co.
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Please send illustrated literature describing
☐ Halsey Taylor Electric Coolers
☐ Ice Coolers

Firm Name.....
By.....
Street.....
City..... State.....

when the voltage of the second or exciting machine was adjusted the voltage of the other exciter was also slightly affected. However, in an emergency it served us well.

•

Charge Accounts

DAVID FLIEGELMAN
Coppus Engineering Corporation
Worcester, Mass.

What accounts to set up for machinery and equipment sometimes seems to be a problem. We use four, and group our different types of equipment as follows:

Machinery Account

1. Machines used in manufacturing.
2. Motors and starters for these machines.
3. Dynamometers and testing machines.

Equipment Account

1. Air compressors.
2. Motors and starters for compressors.
3. Motors and controls for freight elevators.
4. Cleaning tanks and painting equipment.
5. Time clocks and hand trucks.

Heating System Account

1. Feed-water pumps and heaters.
2. Hot water heaters and tanks.
3. Unit heaters and ventilators.

Buildings Account

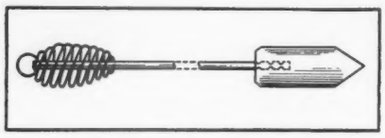
1. Steam boilers.
2. Freight elevators.

Motion pictures are an effective method of teaching safety, Standard Oil Company of California found. They filmed safe practices in the plant, and reenacted accidents to show what not to do.

Handles for Soldering Coppers

S. H. COLEMAN, *Roanoke, Va.*

An ordinary steel stove poker having a coiled wire grip can be made into an ideal handle for soldering coppers. Such a handle is cool to



the touch, and durable. These pokers are available in a number of sizes and can be readily adapted to any

PROTECTION
WHEN NEEDED MOST

Pyroil's efficiency is most notable when emergencies arise. Pyroil takes the shock load and protects the equipment. Often, severe damage, shut down or heavy expense is offset because Pyroil was "in there", protecting vital working parts.

Pyroil has been safeguarding equipment for many years in all parts of the world. Test it in your plant. Call our Distributor. Or, write. Pyroil Company, W. V. Kidder, Founder, 655 LaFollette Avenue, La-Crosse, Wisconsin, U. S. A.

DAYTONS Offer You Savings!

Every day it becomes more important for you to cut costs, and the Dayton Safety Ladder will help you. Daytons save twice! They cut accident costs and increase workmen's efficiency. Either of these Dayton savings is worth the low cost you pay for one or more Dayton Safety Ladders.

Daytons are made of durable airplane spruce, in sizes 3 to 16 feet. Stand firmly. Straight back permits close work.

(*Made in Cincinnati*)

Write Dept. FMM-6 for details

THE DAYTON SAFETY LADDER CO.
121-123 West Third St. Cincinnati, Ohio

DAYTON Safety Ladder
(Patented)

• *Send for our new catalog No. 5 showing a complete line of accident prevention equipment.*

Is yours one of the 100,000 plants that are under wired? Are you spending too much money for maintenance and not enough for modernization? Are you in step with modern methods that provide full speed for men, motors and machinery? In short, is your plant equipped with adequate wiring — the system that gets things done?

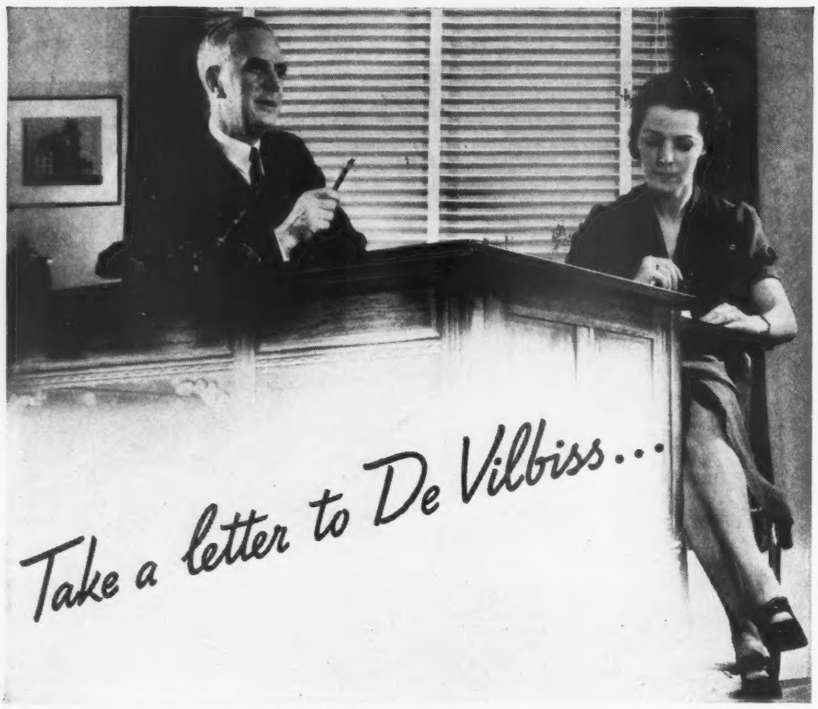
Only adequate wiring makes it possible to get things done economically. Only adequate wiring gives you the full use of the power you pay for.

For adequate wiring, the use of quality wiring materials, designed and tested for long life and efficiency, is an economical, long-term investment in service and plant protection.

General Electric Wiring Materials are quality-built. They are designed to be used together for easy installation. The G-E line is complete, with conduit, wire and cable, and wiring devices to satisfy all your requirements.

Ask your nearest G-E Merchandise Distributor for further information, or write to Section CDW-8246, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

GENERAL ELECTRIC



"Gentlemen: Here's our problem"...

That's the way the letters begin—dozens of them—received every week—by DeVilbiss—letters asking for help in solving some difficult or different product finishing problem. And seldom do DeVilbiss Spray Experts fail to find the answer—even though that answer may require the designing of new spray equipment.

DeVilbiss Spray-Painting Systems include the widest range of equipment needed for the better, quicker, more economical painting of products of every kind—from golf balls to railroad cars.

DeVilbiss Service goes far beyond the sale of equipment to meet your needs—exactly. It is the tangible expression of an old DeVilbiss policy to see to it that every piece of DeVilbiss equipment performs satisfactorily—makes money for *you*.

DeVilbiss Experts are trained in every phase of the spray-painting business—the production, cleaning and regulation of air—the feeding of material and air to the spray gun—the ventilation of the painting area. DeVilbiss Spray Experts are at your command—at any place, at any time. Write, wire or 'phone. The DeVilbiss Company, Toledo, O.

The most advanced type of spray-painting and finishing equipment, exhaust systems, air compressors, hose and hose connections.

DEVILBISS SPRAY SYSTEMS

1888 · FIFTY YEARS OF QUALITY PRODUCTS · 1938

weight bit by merely choosing one with the proper shaft diameter and cutting to the desired length.

There are several methods of fastening the handle and shaft to the copper. Small and medium-weight bits can be drilled and tapped, the end of the shaft threaded, and the two screwed together. An alternative to this, shown in the drawing, is to file notches in the end of the rod, place it in a smooth hole drilled in the copper, and then set the surrounding metal with a hammer and punch. This method of fastening will insure a permanently tight connection.

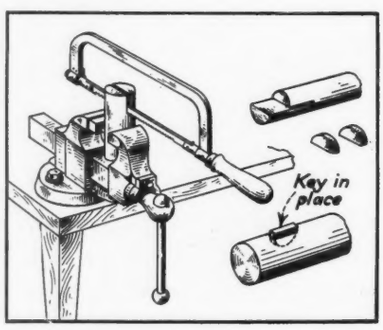
Heavier coppers having shafts forged in at the factory can be attached to the handle assembly by shortening both shaft sections, then welding them together.

In spring cleaning, windows should be near the top of the list. Daylight costs nothing, so why exclude it in favor of artificial lighting.

Easy-to-Make Woodruff Key

CHAS. H. WILLEY, *Penacook, N. H.*

For that notebook of short cuts, here's a way to make a woodruff key quickly and simply. Using a hacksaw, several of these keys can be cut from a short length of steel rod. After sawing a slot lengthwise down the rod, half sections are cut off and filed to fit.



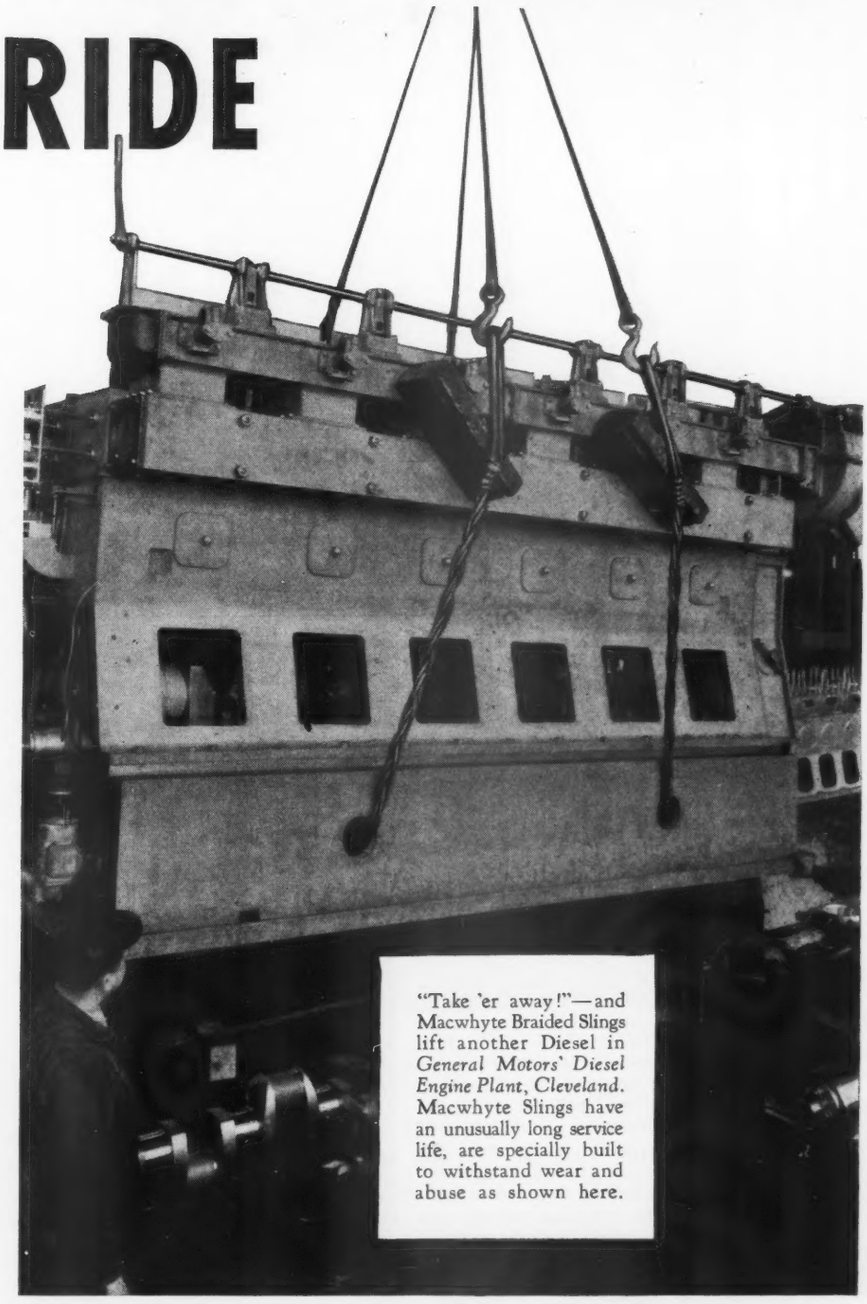
Socket Wrench for Small Nuts

S. H. COLEMAN, *Roanoke, Va.*

A handy socket wrench for hard-to-reach small nuts can easily be made from copper or brass tubing having a diameter slightly greater than the greatest diameter of the nuts. The wrench is constructed by screwing a number of nuts tightly together on a bolt, facing them up, then inserting

Macwhyte
Braided Wire Rope Slings

TAKE A 'DIESEL' FOR A RIDE



"Take 'er away!"—and Macwhyte Braided Slings lift another Diesel in *General Motors' Diesel Engine Plant, Cleveland.* Macwhyte Slings have an unusually long service life, are specially built to withstand wear and abuse as shown here.

● Here was a tough job for any sling—lifting and carrying 52,000 pound Diesel engines from assembly to testing departments. Macwhyte engineers helped solve the problem of quick, safe transfer with *specially designed multiple-part slings*, Atlas Type No. 1.

Safety Built In

Macwhyte Slings are made of endless wire ropes, specially braided together in patented construction. This gives them unusual strength, extreme flexibility, and long service life. It makes them kink-resisting and easy to store in any convenient small space when not in use.

Like General Motors, many other manufacturers are finding today that the way to handle loads quickly, safely, and *more* economically is to use Macwhyte Braided Wire Rope Slings.

WRITE FOR FREE PICTURE BOOKLET

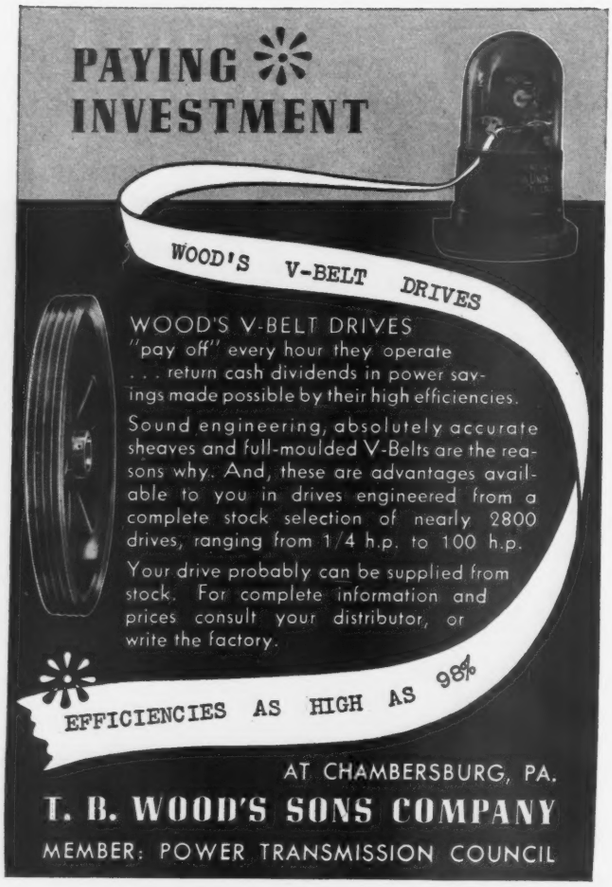
—"How to Handle Loads Safely." Shows many "on-the-job" pictures of Macwhyte Braided Wire Rope Slings handling difficult materials problems.

MACWHYTE COMPANY
KENOSHA, WISCONSIN
Manufacturers of Wire Rope and Braided Wire Rope Slings
● Distributors throughout the U.S.A.

Member National Safety Council

NO. 334

MACWHYTE
Braided WIRE ROPE *Slings*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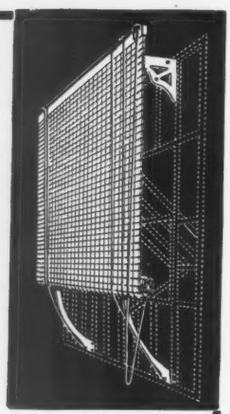

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Send the attached coupon for interesting data; give us the measurements of your openings and we will gladly submit an estimate without any obligation.

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the assembly in the end of a piece of tubing cut to the desired length. This length should be sufficient to provide handle space.

The copper or brass is hammered down and drawn out, using the nuts as a die, until it assumes the proper form. After this, the nut assembly is driven out by tapping on a rod inserted in the opposite end of the tubing.

If when first used the wrench is too tight to slip over the nuts for which it is intended, it can be stretched by replacing the die and tapping the projecting bolt on all sides with light hammer blows.

The portion of the tubing left unhammered serves as the handle. It can be bent at right angles to give leverage, or it can be left straight and some other type of handle attached. A wrapping of friction tape will give a better grip.

Your quality control problem may depend on temperature of one or more solutions used in processing. Small immersion heaters will keep temperatures constant, quality uniform.

Exhaust Heads Save Roofs

H. C. SLEMAN, *New York*

Roof maintenance costs can be substantially reduced if all exhaust steam vent lines extending above the roof surface are equipped with exhaust heads. In the absence of these devices, hot water carried up with the steam can do much damage, not only to the roof, but to flashings, parapet walls, and adjacent structures.

Hot water and steam affect roofing in a number of ways. They soon destroy paint on metal surfaces. Once the paint is gone, rapid corrosion takes place. Slate and tile are not built to withstand rapid temperature changes, and soon crack up. Built-up or composition roofs are likely to pull away from flashings when, after being exposed to the softening influence of hot water, the heat is removed and they harden and contract. Oil present in some exhaust steam will cause rapid rotting of these surfaces.

During the winter months deterioration proceeds rapidly. Vapor entering the fissures around flashings condenses in the joints, and, when temperatures go low enough, freezing takes place. The expansive action

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$27 YOU CAN START A TESTING SET

ONE AP-9 voltmeter, net price only $27, can form the basis for your testing set. With this single instrument you can begin to capitalize the many ways in which instruments may point the way to savings. It's a simple, inexpensive way to turn power losses into power savings.

The AP-9 is a handy instrument. Compact, like a modern camera, it's easy for the service man to carry and use. It's built to stand up under hard usage. The accuracy is ¾ of one per cent of full-scale value—high enough for almost every commercial testing job. You'll find many uses for the AP-9 voltmeter in your plant.

Later, when you have begun to realize the savings these instruments make possible, you can increase your testing facilities with others from the AP-9 line—ammeters, milliammeters, and wattmeters. Start your testing set now. Call the nearest G-E sales office today. General Electric, Schenectady, New York.

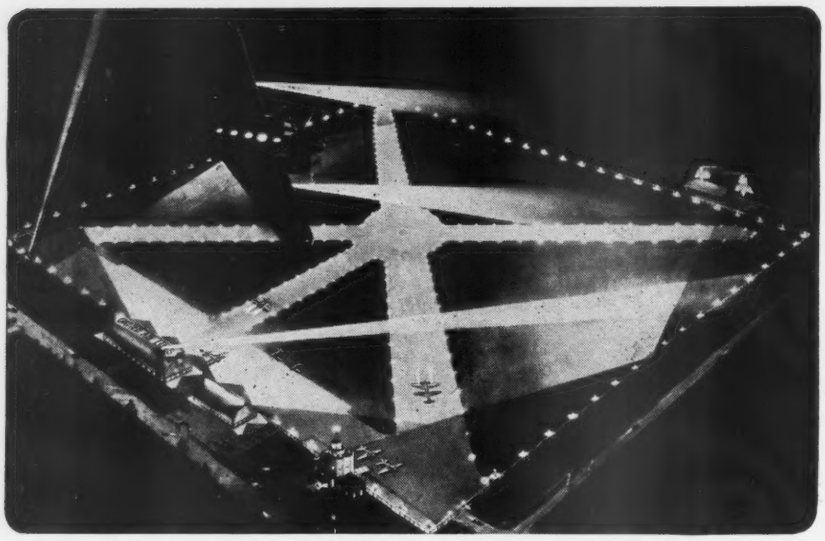
GENERAL ELECTRIC

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

430-100

How United Air Lines makes night flying *SAFE*

THIS UNUSUAL PHOTOGRAPH of a United Airlines plane landing at Chicago Municipal Airport shows the importance of light in the night flying picture. Instruments and radio beams guide planes in the air, but pilots must still see before they can land.



IT TAKES 700,000 WATTS to light this airport. It takes good lamp bulbs to give maximum light for current consumed. That's why United uses G-E MAZDA lamps. They are 46 per cent more efficient than in 1921, 12 per cent more efficient than a year ago.

WHETHER YOU'RE running an airline, managing a factory, or superintending a department, it pays to use General Electric MAZDA lamps. More than 180 different tests and inspections in manufacture help assure uniform quality. New low prices on 75 watt and larger sizes make these bulbs more economical than ever.

GENERAL ELECTRIC
MAZDA LAMPS
They stay brighter longer

of the ice forces the joints apart and soon destroys all seals against leakage.

Where parapets are capped with concrete or tile, cracks will develop in cold weather, especially if the hot water strikes intermittently. Another trouble frequently experienced is the formation of ice on the roof surfaces near the exhaust vent. These accumulations often build up to a point where their weight imposes severe strains on the roof's supporting framework.

Most of these troubles can be avoided by installing properly designed exhaust heads. These devices separate the water from the steam, so that the water can be piped separately to a drain. Much wetting from steam condensing after leaving the vent can be eliminated by carrying the vent pipe as far as possible above the roof. This will allow air currents to carry away the droplets before they can fall on the roof surfaces.

•

Acid Removes Iron Stains from Tile

R. A. Bird, *Philadelphia*

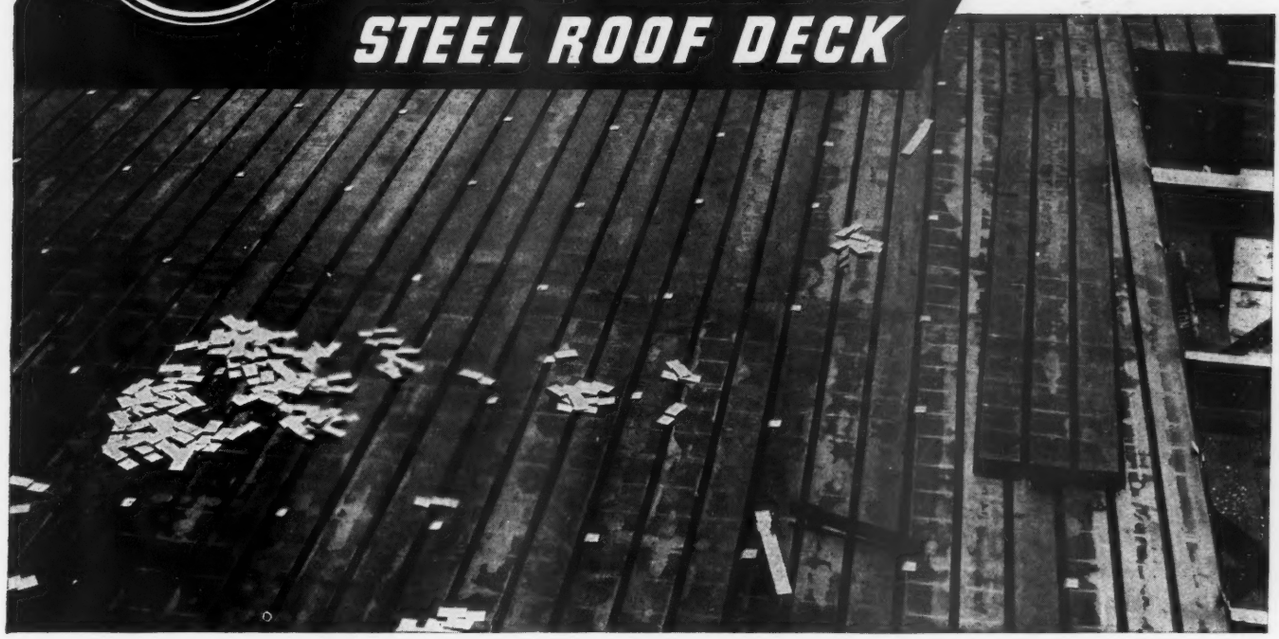
Red stains on tile floors, walls, and porcelain fixtures of sanitary equipment are hard, if not impossible, to remove with ordinary cleaners. These unsightly deposits are usually caused either by rusting of adjacent iron, or by iron compounds dissolved in the water supply. This dissolved iron may be a natural constituent of the water, or it may result from corrosion in the piping system. In any case, the stains detract from appearance, and give an impression of laxity in maintaining proper sanitary conditions.

It is possible to remove stains of this nature, if they have not penetrated too deeply, with a solution of commercial hydrochloric (muriatic) acid. A mixture of equal volumes of acid and water applied with a brush to the affected surfaces will ordinarily give excellent results. Except in very stubborn cases, one or two applications of the acid should cause all discoloration to disappear. After the surface is clean, it should be washed thoroughly to remove any acid remaining.

Tile floors and walls that have become dingy can be restored to their natural color by using this procedure. When mixing the water and acid, goggles and rubber gloves should be worn to avoid getting the acid in the eyes or on the skin, for bad burns can result if care isn't used.

Wheeling
CORRUGATING COMPANY

Tri-Rib
STEEL ROOF DECK

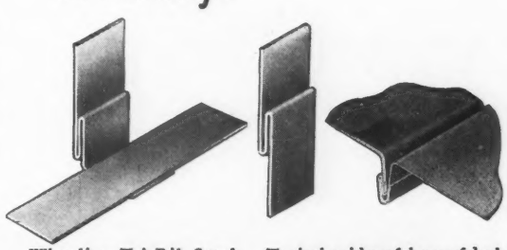


—The *NEW WAY TO ROOF INDUSTRIAL BUILDINGS* AT LOWEST COST

● In modern factory construction, the Wheeling Tri-Rib Steel Roof Deck provides a rigid, firesafe and economical roofing foundation that can be applied in record time. There are few units to handle; each consisting of a sheet of COP-R-LOY 18" wide, reinforced with three ribs spaced 6" on centers. These plates are 18, 20 or 22 gauge. They are joined together and attached to the purlins or other supports by clips or welding. Workmen can do the erecting from the top of the roof deck. There is no cutting or fitting on the job. The ends of adjoining plates overlap to form a rigid platform with a smooth surface throughout.

COP-R-LOY, Wheeling's tough, rust-resisting copper alloy, gives this steel deck extra long life. It is painted or galvanized. Write for complete details.

1. *Easily Handled*
2. *Quickly Applied*
3. *Firesafe*



Wheeling Tri-Rib Steel Roof Deck is fastened by specially designed clips. Above is the purlin clip to attach the deck to beam, channel or joist purlin.

To tie the sides of the roof deck plates together, intermediate clips like that shown above are furnished. The illustration at the right shows the intermediate clip in use.

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WHEELING, WEST VIRGINIA

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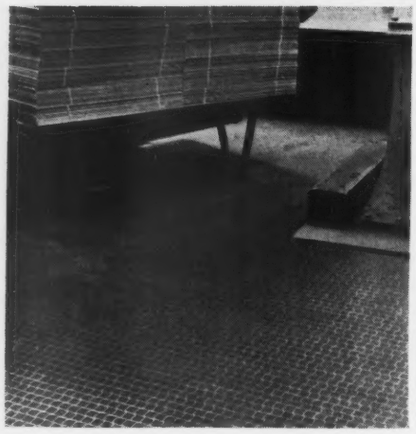
"We've Eliminated FLOOR MAINTENANCE COSTS"



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You can obtain the same benefits that dozens of other concerns have received by installing Acme Heavy-Duty Floorsteel. Eliminate maintenance costs. Holes and ruts cannot develop. A lasting, smooth, quiet and non-skid surface is provided. Where one installation is made, the savings are so marked that several other installations often follow for the same company.

ACME HEAVY-DUTY FLOORSTEEL, designed to take the brunt of rolling loads, is shipped in standard one-piece rolls 47½", 60" or 72½" wide by 25 ft. long. (Special sizes at no extra cost.) The small mesh, 1¼" x 1¼"—⅝" deep, is imbedded, flush with the top of the floor, in concrete, asphalt or other suitable material to provide a floor that will remain smooth and even.

A FREE SAMPLE SECTION and complete information will be sent for your inspection. There is no obligation. Mail the coupon today.

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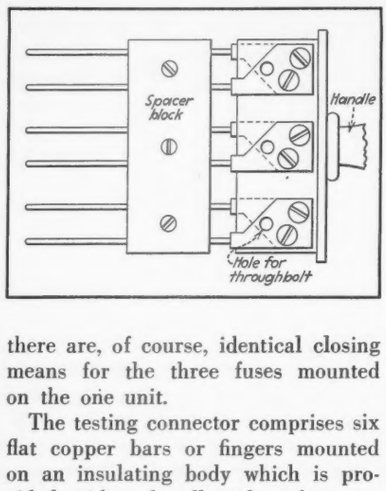
Quick Connections for Motor Testing

R. B. STRASSEN, *Electrical Engineer Owens-Illinois Can Company, Chicago in* ELECTRICAL WORLD

Biggest part of the job of testing motors in operation is connecting and disconnecting the instruments. To do this quickly and safely is a problem that has had almost as many solutions as the number of men who have worked on it. As a matter of fact, the best instrument-connection device in any instance is likely to be the one that was designed to fit the particular case. For example, the one shown in the sketch is in regular use in our Clearing, Ill., plant and was designed for use with Square D Saflex fused, dead-front distributing panels.

In this type of panel connection to the line side of the fuse is made by means of a piece of copper bar bent into U-shape and fastened to an insulating block held in the cover of the panel unit. The block may be set in two positions in the cover. In one position, closing the cover closes the circuit, and in the other the cover may be closed while the circuit remains open. In a three-phase unit



there are, of course, identical closing means for the three fuses mounted on the one unit.

The testing connector comprises six flat copper bars or fingers mounted on an insulating body which is provided with a handle taken from an old knife switch. The bars are properly spaced, held for rigidity in a spacer block as shown, so that they will enter the clips of the Saflex unit. Alternate bars terminate on the two sides of the insulating body in brass plates which are provided with screws, under whose heads are placed the lugs of the test leads. The matching plates on the two sides of the body are tapped for reception of through-bolts, by which means any of the three pairs of fingers may be short-circuited if a series test connection is not desired in that particular phase.

With this device all testing instru-

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Note the screw's tapered recess — its angle was worked out after months of tests to learn how to utilize the driver's maximum turning power. Note the flat surfaces — no curves except at the rim. That prevents the driver from burring the screw. Machined to tolerances of plus or minus .001" — to guarantee a perfect fit. Hand, spiral, or power drivers may be used — available from leading manufacturers and distributors.

GAINS TIME

FASTER WORK WITH HALF THE EFFORT

One-hand starting and driving. Three times the contact between driver and screw. Faster driving method cuts time to a fraction.

GUIDES DRIVER

AS EASY AS POINTING YOUR FINGER

Awkward places easy to reach — the screw clings to the driver. Self-centering — straight line driving — no screws driven crooked.

GUARDS WORK

BETTER WORK — AND NO SPOILAGE

The driver can't slip out of the recessed head. No split heads — no burrs to remove. Better holding power — the screw sets up much tighter.

from **SLOT** *to* **RECESS** *a simple step*

that strikes out thousands of dollars in production costs

A simple change in the basic design of a screw . . . is revolutionizing the fastening practices of the leaders in the screw-using industries. Big automotive plants, big sheet metal fabricators, big furniture makers and others are standardizing on Phillips Screws *with the patented recessed head* . . . and are saving thousands in the cost of production.

Thousands in the cost of screws. The recessed head clings to the driver's point . . . and better holding power per screw permits use of fewer screws or smaller, lower-cost sizes.

Thousands in the cost of time. Faster driving methods can be safely used . . . one hand is free to hold the work . . . extra operations like magnetizing and removing burrs and split screws are eliminated.

Thousands in the cost of the finished job. Men less tired, turn out more first-grade work per day . . . there are no scars on the work or hands caused by slipping drivers. And assemblies are tighter.

Less screws . . . less hours . . . less spoilage. There's a place in *your* plant for this modern fastening device. Get full information by writing to one of the firms listed below for Folder A. See coupon below.

PHILLIPS RECESSED HEAD SCREWS

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MACHINE SCREWS **SHEET METAL SCREWS** **WOOD SCREWS** **STOVE BOLTS**

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And Watch Your Costs Go Down

FOR a personal demonstration of what worn, wobbly, muscle-bound running gears do to your material handling schedules and costs . . . try walking across your office floor hobbled with a grain bag. You'll get there eventually. But you won't break any speed records. And your protesting muscles will tell you why the man pushing a friction-locked truck greets quitting time with such enthusiasm.

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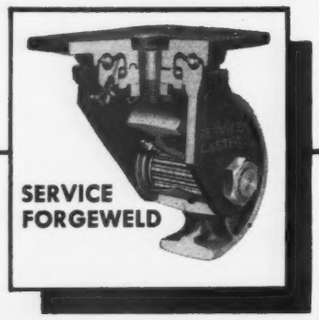

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Service

CASTERS and PUSH E-Z TRUCKS

ment connections are made to the terminals of the plug, which is then inserted in the switch clips. Safety is thus afforded by elimination of the need for making "hot" connections, and speed is gained by the fact that test connections remain fixed during a series of tests.

Time spent resurfacing sanding drums can be cut by putting on several sheets of abrasive paper in layers. Let them overlap each other by about 2 in., and glue for about ½ in. along the outer edges. When surfaces become dull, just tear off the top sheet.

Salvage Broken Pipe Covering

G. B. SANDS, *Springfield, Mass.*

When repairs are made to steam piping systems, it is almost impossible to remove all of the heat insulation in re-usable form. Sections of covering may have been damaged in service or broken up as they were removed. This perfectly good asbestos or magnesia is ordinarily thrown away, and the lines re-insulated with new covering.

One large plant has found it profitable to salvage broken pieces of covering by reworking them into blocks that can be used in insulating large pipe lines, tanks, heaters, and boiler drums. The bad pieces are first ground, then mixed with water, and poured into forms having the desired shape. After they have been dried with a current of warm air, the blocks are removed, ready for use wherever needed. Where conditions to which the insulation will be subjected are unusually severe, pieces of wire netting are embedded in the blocks to give additional strength.

At another, much smaller plant, the broken insulation is shredded by hand into very small pieces, and placed in discarded grease drums which have been thoroughly cleaned. When the drums are full, the material is covered with water and allowed to soak for two or three weeks. During this soaking period the pieces disintegrate and settle to the bottom. To insure thorough penetration of the water, the mixture is stirred occasionally. When the pieces are thoroughly wetted and all lumps have broken down, surplus water is poured off, and the plastic material is mixed with long-fiber asbestos and used wherever an insulating plaster is required.

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PLANNED Power Transmission helped to meet every variation in production requirements in the new plant of the Ahlberg Bearing Company, Chicago, Illinois.

By grouping — batteries of 8 grinding and polishing machines are being operated — each battery by a separate motor. This system provides compact drive construction — better production control and efficiency — and assures both quantity and precision grinding and polishing of bearing races.

This arrangement reflects many economies. The installation cost and required horse power capacity are considerably below the cost of individual drives, had they been employed exclusively — Besides the power consumption per unit of product produced is below that of the old plant.

This is but one of hundreds of cases where — Planned Power Transmission produced the ultimate in effective power utilization — lowest possible power costs and maximum production. Our representative will gladly explain other cases to you personally upon request — Write today.

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A cooperative organization of Power and Power Transmission Equipment Manufacturers devoted to the Advancement of the Technology of Industrial Power Transmission

We've Learned More About H.I.M.V. Lamps

(Continued from page 87)

any one, or a combination of, at least three different lamp sizes.

A dust-tight and vaporproof, high-bay unit is illustrated in Figure 2 *E*. It has an outer steel housing and cover glass of heat- and impact-resisting glass, and is equipped with an Alzak-processed inner reflector for low, medium, or high mounting. It is designed to take the 400-watt high-intensity lamps.

Many industrial areas have ceiling heights of less than 12 ft. which restrict the mounting height of lighting equipment. In such areas fixtures equipped with 400-watt mercury lamps are excessively bright, and objectionable glare results. The solution lies in the use of the 250-watt mercury lamp, which is ideal for mounting heights as low as 8 to 10 ft. It is also extensively used at mounting heights in excess of 25 feet.

High-intensity mercury vapor lamps will operate only on a.c. circuits, preferably at a frequency of 60 cycles, and in connection with a suitable current-regulating device, either transformer or reactor. An individual unit must be used with each lamp in order to accommodate the variation in voltage and arc resistance as the mercury vapor pressure increases.

Ballast equipment for operation of high-intensity mercury lamps at 50 cycles can be obtained, but a slight increase in stroboscopic effect is noticeable at this frequency. Operation of these lamps at any frequencies lower than 50 cycles is definitely not recommended.

Starting and operating characteristics of the 400-watt lamp are such that a reactor is used in series with it on 220 to 240 volts, whereas a step-up transformer should be used when the service voltage ranges from 107–123 or 190–208 volts.

Since the starting and operating voltages of the 250-watt lamp are considerably lower than those of the larger lamp, reactors are not recommended. Instead, transformers with proper secondary voltage characteristics are used with these lamps in all three of the common or commercial voltage ranges.

All reactors and transformers are equipped with several line voltage taps which are usually matched with the available line voltage, using the tap that is nearest to it. This practice closely limits the wattage input to the lamp, and guarantees proper operation of both lamp and ballast device over long periods.

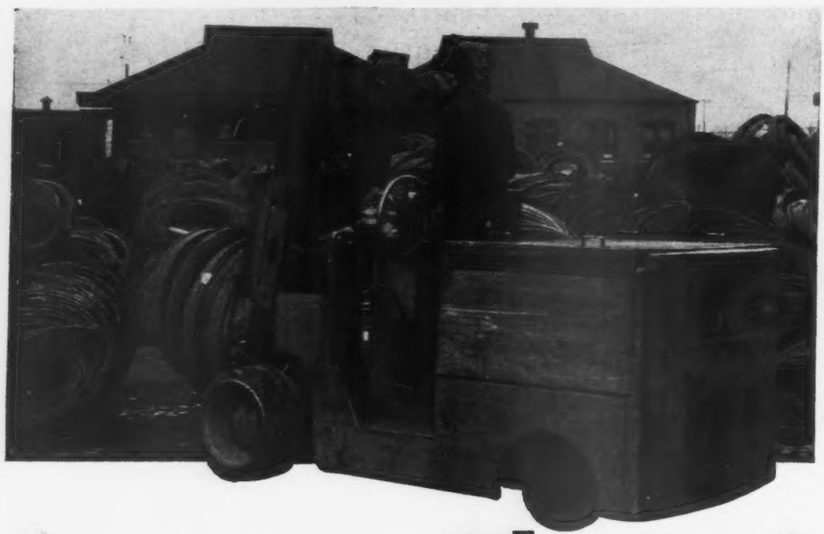
They Require Transformers

Transformers and reactors can be had for either wall or suspension mounting, as required. It is good practice to keep the run from secondary to lamp as short as possible. Therefore, where there is sufficient clearance above the lighting unit the suspension-mounting type of unit is favored. It is usually installed in the conduit line between outlet box and fixture. Figure 3 *A* illustrates this type of installation.

When Lights Are Low

In low-ceiling areas or where for any reason it is desired to group the ballast equipment, wall-mounting designs can be installed on the ceiling adjacent to the unit, or they may be grouped at some remote point. Figure 3 *B* shows ceiling-mounting arrangements.

Use of reactors or high-reactance transformers with high-intensity mercury vapor lamps results in a power



Put 'er There!

Rod or wire, strip, sheet or tin plate, the Baker Center Control Truck (with fork or ram) "puts 'er there" with speed, efficiency and economy. In many of the country's most important mills it is writing new lows in handling costs.

- The center control position affords full visibility and assures operator complete protection.
- Wide angle, rear wheel steering permits maximum maneuverability in small space.
- Exclusive "No Plug" control compels careful operation — insures against damage through sudden reversal.
- Tilts (and retains) load while traveling — handles 6,000 to 30,000 pounds.

This type is just one of the Bakers saving time and money in many industries. The Baker Material Handling Engineer will give you data on their savings. He will estimate the possibilities in your own plant. Have him get in touch with you. Write today.

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fire is a THUG!

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HAVE you ever seen fire strike down a smooth-running prosperous business—and leave it gasping for life? It has happened. It will happen many times again.

Fire is a thug! It stuns production. It stops vital shipments. It cripples the morale of salesmen and workers. *You can't afford a fire*, no matter how complete your insurance coverage.

For your own peace of mind do this: see that every fire hazard in your plant is well guarded. If you have electrical equipment or flammable liquids, protect them the best known way—with LUX carbon-dioxide extinguishers. Lux snow-and-gas is the *fastest recorded extinguishing agent*. Lux snow is clean, dry, non-corrosive, and has no fumes.

You may buy Lux portable extinguishers, or, for a concentrated hazard, a Lux Fixed System. Send for "Lux Makes The Difference" which describes both methods.

Why not write now? Be ready for fire when it strikes.

LUX
SNUFFS OUT FIRE

Walter Kidde & Company
62 West Street, Bloomfield, New Jersey

factor of only 60–65 per cent with the 400-watt lamp and approximately 50 per cent with the 250-watt lamp. However, a suitable capacitor operated in conjunction with the transformer or reactor will raise the power factor to 90–95 per cent. Consequently, the transformer-capacitor or reactor-capacitor type of auxiliary is recommended, except in very small installations or where facilities for group correction of low power factor are available.

Ballast equipment for 400-watt lamps cannot be used with 250-watt lamps, or *vice versa.*

Errors Pushbuttoned Out

(Continued from page 82)

operator can stop the turntable and start it again the next morning by pushing a control button, without going through the sequence necessary on Monday morning.

The product is discharged from each final-mix tank in sequence into an auxiliary storage tank below. From this tank it is pumped through a filter press and special milling equipment, and from there to final storage, Figure 3. Glass-lined tanks are used in all of these processing operations.

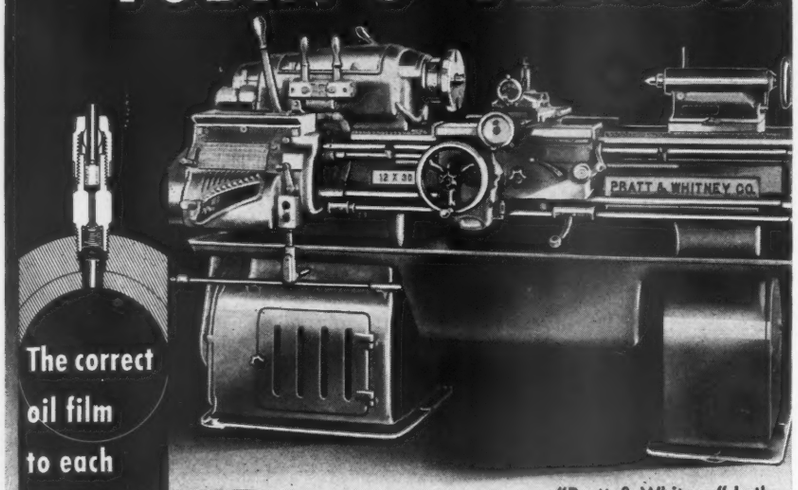
What was the purpose of Campana engineers in developing this almost fully automatic processing from raw material to storage? Contrary to what might be thought, it was not the desire to save labor, although there has been a substantial saving in this item. Primarily the set-up was evolved to make it impossible for any product to get out that is defective through mistakes either in the kind or amount of ingredients, or in processing them. Raw materials are started into circulation directly from original containers and are handled in such fashion that they cannot get out of their foreordained channels. Their quality is controlled by laboratory analysis. Therefore, if a shipment gets into stock it is up to standard and thereafter it flows straight through into the automatic mixing departments. The sole exception is the compounding of perfumes from essential oils, mentioned at the beginning of this article. Even here the routine is set up in such manner as to make it practically impossible for the perfume chemist to make an error. And after the essential oils have been mixed the concentrate goes into the process as just another raw material which is automatically controlled in the journey through the plant.

Right or Not at All

The heart of the plan is the automatic control of weighing, proportioning, batching, and mixing of ingredients. The quantities and times are automatically controlled with scales, electric eyes, and other direct-acting pieces of equipment. Once the process is started it must continue through to precisely accurate completion or else stop altogether. Material can go from one process to the next only if everything is accurate within a small fraction of 1 per cent.

Before the new building was occupied last autumn, manufacturing operations were seriously handicapped by cramped working space and scattered departments. Compounding, measuring, weighing, control of processes—all was manual, subject to human error. Supervision, inspection, and check-up at every step were exacting and expensive. Today all that is required is laboratory control of the raw materials and of the finished product before it is released for packaging.

YOU *Must* CONSIDER TODAY'S TRENDS!



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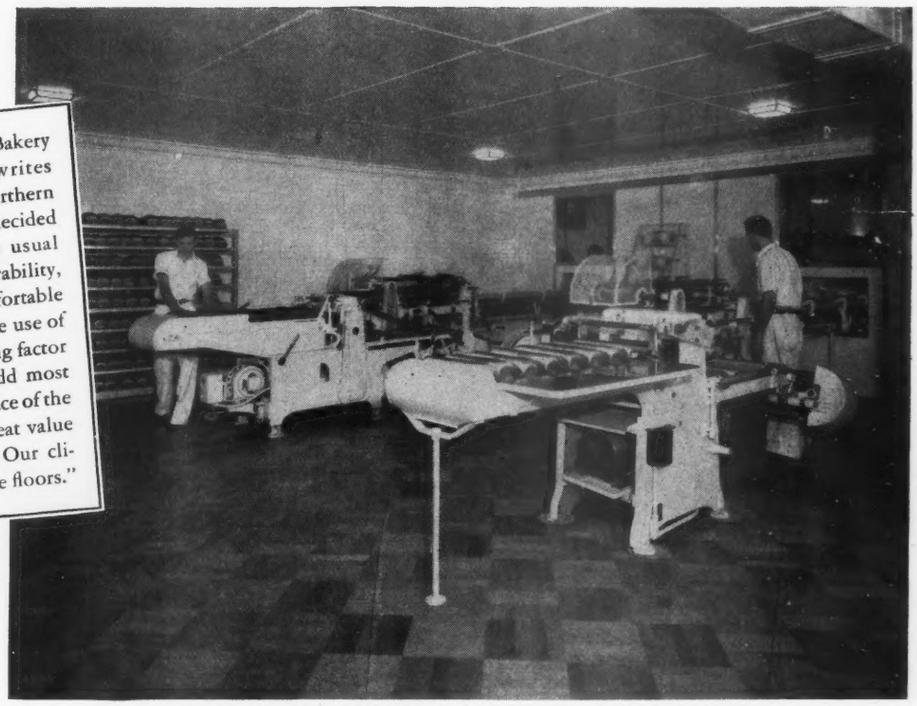
916

"...OUR CLIENTS ARE VERY PROUD OF *Their Maple Floors*..." says The W. E. LONG CO., *Bakery Engineers, Chicago*

"In the rehabilitation of the Smith Bakery at Mobile, Alabama in 1937," writes The W. E. Long Co., "33/32" Northern Hard Maple block flooring was decided upon for flooring material. The usual consideration was given to the durability, ease of cleaning, long life and comfortable working conditions incident to the use of Maple Floors, but the final deciding factor was that Maple Floors would add most materially to the finished appearance of the entire plant and would be of great value from an advertising standpoint. Our clients are very proud of their Maple floors."



Northern Hard Maple block floor in the Smith Bakery at Mobile, Alabama

YES, factories *can* take pride in the bright and shining face Hard Maple shows plant visitors. For this smooth, light-reflecting floor captures sunlight — cheerfully suggests the constant sanitation that should be identified with every factory. Non-porous, it offers no lodging places for germ-laden dust. Employees, too, appreciate working on Maple—it's warm, dry, and easy underfoot — so that management profits by increasing efficiency and reducing fatigue.

These are the intangible profits of Hard Maple Floors, but your cost figures will show you tangible ones. For tough-fibred, tight-grained Hard Maple shows remarkable resistance to abrasion and indentation — even the heavy pounding of trucks does not develop slivers, splinters, or ridges through the years; yet, being wood, it creates no injurious dust—simplifies alterations—machinery is firmly anchored. Maintenance is simple and inexpensive. Properly finished, brushing alone keeps Hard Maple clean. On every count, it offers remarkable economy.

Before building or remodeling, investigate this superior flooring. And when you buy be sure it's **MFMA*** Northern Hard Maple—available in strips or blocks.

MAPLE FLOORING MANUFACTURERS ASSOCIATION

1787 McCormick Building, Chicago, Illinois

See our catalog data in Sweet's, Sec. 11/76.
Write for folder describing good service finishes for old or new Hard Maple floors.

To be sure of Association guaranteed grading, specify and look for the* **MFMA *trademark (indented and stamped). The following manufacturers are licensed to use it:*

Beck, August C. Co., Milwaukee, Wis.
Brown Dimension Co., Manistique, Mich.
Bruce, E. L. Co., Memphis, Tenn. (Mill at Reed City, Mich.)
Connor Lumber & Land Co., Laona, Wis. (Sales Office, Marshfield, Wis.)
Farrin Lumber Co., M. B., Cincinnati, O.
Holt Hardwood Co., Oconto, Wis.
Kerry & Hanson Flooring Co., Grayling, Mich.
Kneeland-Bigelow Co., Bay City, Mich.
Kneeland-McLurg Flooring Co., Phillips, Wis.
North Branch Flooring Co., Chicago, Ill.
Oval Wood Dish Corp., Tupper Lake, N. Y.
Robbins Flooring Co., Rhinelander, Wis.
Stephenson Company, I., Wells, Mich.
Wells, J.W. Lumber Co., Menominee, Mich.
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Yawkey-Bissell Lumber Co., White Lake, Wis.

Floor with MFMA Maple

(NORTHERN HARD)

Watch What You Ask of Your Drives

(Continued from page 79)

the mechanical slipring starter, by virtue of their ability to take the motor off the line after the load has been released.

Importance of using properly designed shafting for driving any type of equipment is sometimes overlooked. It occasionally happens that equipment is furnished with a shouldered shaft. This is done for reasons of economy since the smaller the diameter of the shaft, the smaller the bearings needed.

One example of this practice is found on the shaft that is a component part of a grinder. This shaft is supported by four bearings, two of which are integral with the grinder casing, while two support the extended portion of the shaft which carries the driving V-belt sheave, as shown in Figure 5. To accommodate the bending stresses imposed by the grinding disks and the material being ground, the grinder portion of the shaft is 4½ in. in diameter. In view, however, of torsional stresses only on the extended driven section of the shaft, it was advisable from the standpoint of bearing economy to reduce the diameter to $3\frac{7}{16}$ inches.

The grinder is driven by a 50-hp., 1,160-r.p.m. motor connected through V-belts to the shaft, which turns at 1,000 revolutions per minute.

During one of the grinding operations it was suddenly noticed that the grinder was stalled, although the motor was running at full speed. Investigation disclosed that the shaft had sheared clean at the point where the diameter dropped from 4½ in. to $3\frac{7}{16}$ in., immediately adjacent to the first outboard bearing. It was then seen that the shoulder was a square cut, without either a fillet or small radius. The cause of the break was therefore immediately obvious.

Weakest Point at Shoulder

The weakest point of a shaft is at a shoulder, particularly when the shoulder is square cut. Torsional and vibratory stresses tend to concentrate at such a point, resulting in fatigue and eventually failure.

In this instance the weakness was overcome by designing the shaft with a fillet of substantial radius at the shoulder. A fillet or radius is imperative at a shaft shoulder, since such a design possesses the property of decentralizing the stresses that produce fatigue.

Badly worn teeth on gear drives can also cause serious trouble. An example involves a 6-ft. diameter by 8-in. face by 1½-in. c.p. spur-tooth ring gear meshed with a 12-in. diameter pinion which is mounted on a short shaft supported by three bearings on concrete piers. This shaft was driven at 250 r.p.m. through V-belts from a 25-hp., 860-r.p.m. motor.

Continuous trouble was experienced with the pinion shaft bearings tearing loose from the concrete piers. Frequent repairs were made, but no cure for the trouble was found. Eventually a careful investigation disclosed that the teeth of the ring gear were worn down so badly in several places that backlash to the extent of more than ½ in. was occurring at regular intervals as the drum revolved. The reaction produced severe vibration of the pinion shaft, although the pinion itself was in good condition.

Recognizing the cause, a successful effort to overcome the trouble and smooth out the drive was made by removing the spur gears and replacing them with a set of herringbone gears.

PROGRESSIVE • • • •

• Here, in America's largest crane-building shops, are born the developments which mean lower and still lower costs for handling heavy materials in your plant.

Through the building of more than 10,000 electric traveling cranes, this group of specialists offers you the experience and ability to solve your problems of material-moving in the most efficient and economical manner. P&H electric cranes are built in all capacities from 5 to 300 tons. Complete information on request. The Harnischfeger Corporation, 4525 W. National Avenue, Milwaukee, Wisconsin.

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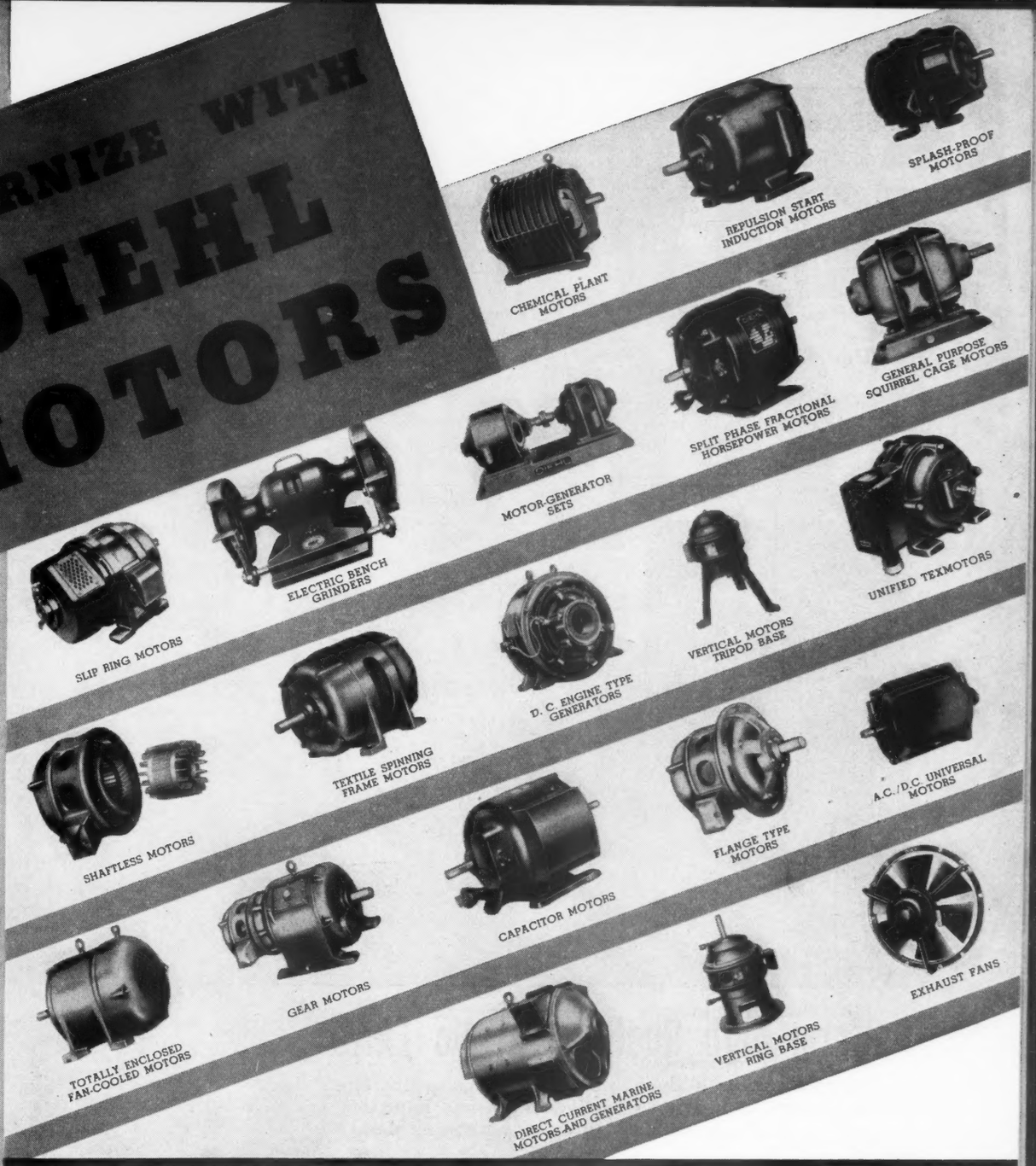
MODERNIZE WITH DIEHL MOTORS



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CHURNS
CIGARETTE MAKING MACHINES
CIRCULATORS, AIR
CLAY MAKING MACHINES
COAL MACHINERY
COKE MACHINERY
COFFEE MACHINERY
COMPRESSORS
CONVEYORS
CRANES
DAIRY APPARATUS
DENTAL MACHINES
DISHWASHERS
DRIERS
ELECTRO-PLATING EQUIPMENT
ELEVATORS
ESCALATORS
FANS, EXHAUST
FIRE ALARM SYSTEMS
FLOUR MILL MACHINERY
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GLASS MAKING MACHINERY
GRINDING MACHINERY
HOISTS
HYDRAULIC MACHINERY
LAUNDRY MACHINERY
LOOMS, TEXTILE
MACHINE TOOLS
- DRILL PRESSES
- PUNCH PRESSES
- SHAPERS
- GRINDERS
- BORING MILLS
- PLANERS
- LATHES
- SHEARS
- BLANKING PRESSES
- ETC.

METAL WORKING MACHINERY
MINING MACHINERY
MIXERS
MOTOR-GENERATOR SETS
OFFICE APPLIANCES
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PETROLEUM PRODUCTS MACH'Y
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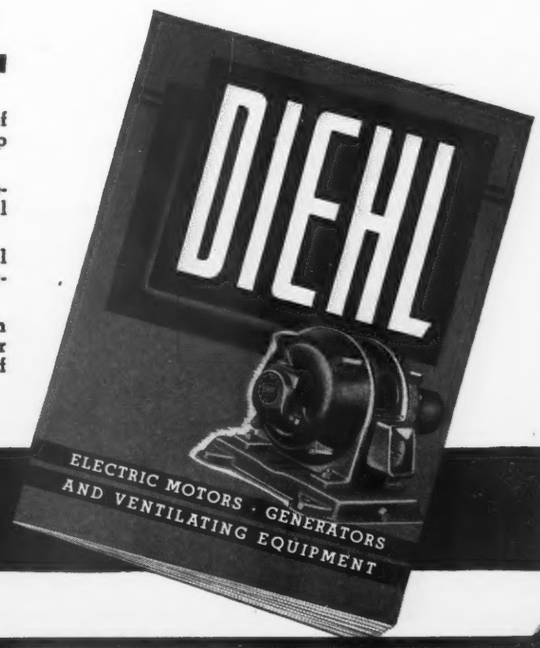
3. Because—the wide range of types and sizes for general or special purpose application—makes possible the selection of the exact motors for your need.

4. Because—they represent half a century of experience in motor building, and are made by a company noted for incorporating in its products approved modern features of design and construction.

WRITE FOR BULLETIN NO. 1881.



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Pioneer Manufacturers of Motors, Generators and Fans
Electrical Division of THE SINGER MANUFACTURING CO.
ATLANTA BOSTON CHICAGO DALLAS NEW YORK PHILADELPHIA

Motion Economy for All

(Continued from page 57)

The devices that have proved most effective in putting this program across have been: (1) Motion pictures and lantern slides, (2) process charts, (3) individual projects.

How Put It Over?

Motion picture loops have been prepared for sample jobs in practically every department of our factory, including some of the clerical departments. These films show examples of operations before and after application of motion economy principles. Also, lantern slides have been made illustrating typical workspace layouts and process charts. These slides and films serve as the basis for class discussions.

In the early sessions of the course the usual procedure is to show a film of a typical operation before application of motion economy principles. To emphasize the points at which these principles are violated, the class develops a right-and-left-hand process chart of the operation. Suggested improvements are discussed, and a process chart of a new method is developed. Then a film of a previously developed "new method" is shown and compared with the one developed by the class.

Often the latter is a really better method. In any case, the relative merits of the two are discussed, thus giving the members of the class experience in applying the principles.

Finally each member of the class is asked to make a process chart of some job he does in the shop. Then he is requested to apply the principles of motion economy to this job, work out an improved method, and make a process chart of the new method.

We then make motion pictures of the "before" and "after" methods of the best projects and call the class together for a later session to discuss these projects. Figures 1 and 2 include "before and after" process charts as well as "before and after" photographs of a typical project worked out by an employee enrolled in one of these classes. This man is a drill-press operator, and the operation involved is spot-facing the pawl pictured in Figure 2, using a single-spindle drill press.

The new method worked out by this operator resulted in a 62 per cent saving in time. But here is the interesting fact. Although the output was increased from 429 to 1,141 per hour, the total fatigue involved is actually reduced. This is because the total distance moved per piece by both hands under the old method was 64 in. compared to only 12 in. per piece for the new method, thus reducing the total distance moved per hour from more than 27,000 in. to just short of 13,700.

Although the percentage of savings in this case is somewhat larger than the average, this is a typical project, and illustrates the kind of result that is attained repeatedly, all over the shop, when the employees become motion-minded.

Who Takes the Course?

The classes are organized on a purely voluntary basis, and conducted as part of the regular factory school curriculum. The instructors are all selected from the regular personnel of the Standards Department.

Employees applying for the course are divided into groups of about 20, all of whom work in the same department or on related types of work. The groups are purposely kept small in order to promote free discussion.

These classes, along with all other

Uniform High Quality—at No Extra Cost

Ryerson certifies to the known uniform high quality of all steels in stock. Tighter, more accurate specifications—rigid inspection and checking—and years of preparation have built up stocks of these better steels.

Ryerson Certified Alloy Steels are particularly outstanding. They are from selected heats that will give the best response to treatment. Special data sheets showing the chemical and physical properties, grain size, cleanliness rating, results of actual heat treatment tests, etc., are prepared. With every shipment Ryerson sends this complete information. The heat treater has an accurate guide for quickly securing the best possible results. These special services are offered without increased cost or obligation.

When you need good uniform steel—a single bar or a carload—order from the nearest Ryerson plant. Immediate Shipment is assured.

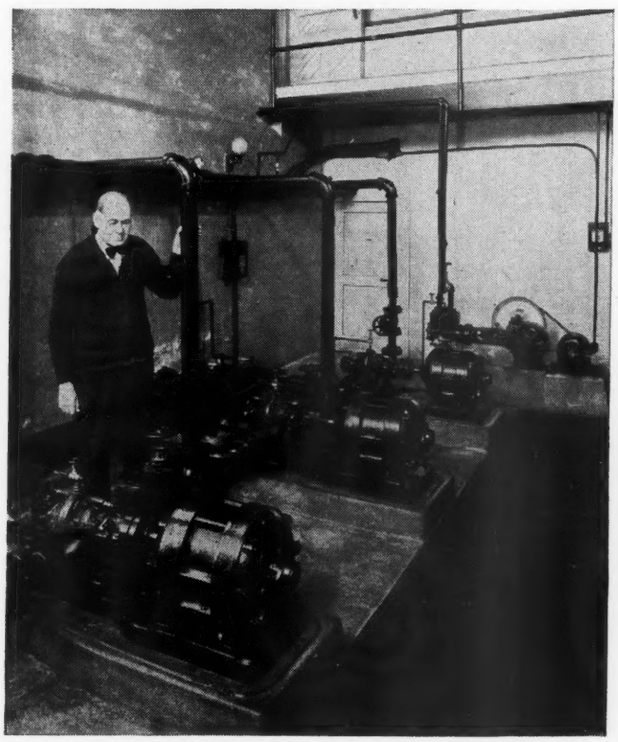
Booklet on Ryerson Certified Steels sent on request.

JOSEPH T. RYERSON & SON, INC. Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City

RYERSON *Certified* STEELS

CITY SAVES $38,000!

Read How City of Hastings, Michigan, Saved Over $6300 a Year in Pumping Costs and Cut Water Rate 15% . . . by Replacing Old Pumps with Allis-Chalmers!



THE WATER DEPARTMENT AT HASTINGS, MICHIGAN. City Engineer Bert Sparks inspects the pumps that have saved the City of Hastings as much as $6372 in a single year! They are an Allis-Chalmers 2½" x 2" Type SJH, rated 250 gpm at 150 ft. head, and two Allis-Chalmers 3" x 2½" Type SJH pumps, each rated 350 gpm at 150 ft. head.

Water rate reduced 15%! Reserve fund of $11,000 built up by a department that previously showed a deficit. $38,000 saved in pumping costs!

That's what actually happened in the City of Hastings, Michigan, when City Engineer Bert Sparks replaced steam driven reciprocating pumps with three Allis-Chalmers motor-driven centrifugal pumps!

It's not hard to understand why! The former fuel cost for steam-driven pumps was 6c per 1000 gallons pumped. But the cost for the Allis-Chalmers motor-driven pumps is only 1¾c per 1000 gallons. That means an actual average saving of $6372 per year to the City of Hastings, in pumping costs alone! $38,000 since the pumps were installed!

Allis-Chalmers Engineering Cuts Costs!

No wonder that when a fourth pump was purchased in the fall of 1937, the City of Hastings specified Allis-Chalmers! For the engineering that has created Allis-Chalmers equipment means lower costs . . . actual savings in dollars and cents. And like savings result from Allis-Chalmers assumption of undivided responsibility for both pump and drive!

What Allis-Chalmers Centrifugal Pumps have accomplished for the City of Hastings, they can do for your city or for your factory. The Hastings installation is typical of the way Allis-Chalmers has solved municipal and industrial pumping problems throughout the country. There's an Allis-Chalmers representative near you. Let him show you how Allis-Chalmers pumps can actually pay for themselves . . . how many dollars they can save!

923

CENTRIFUGAL PUMP DIVISION

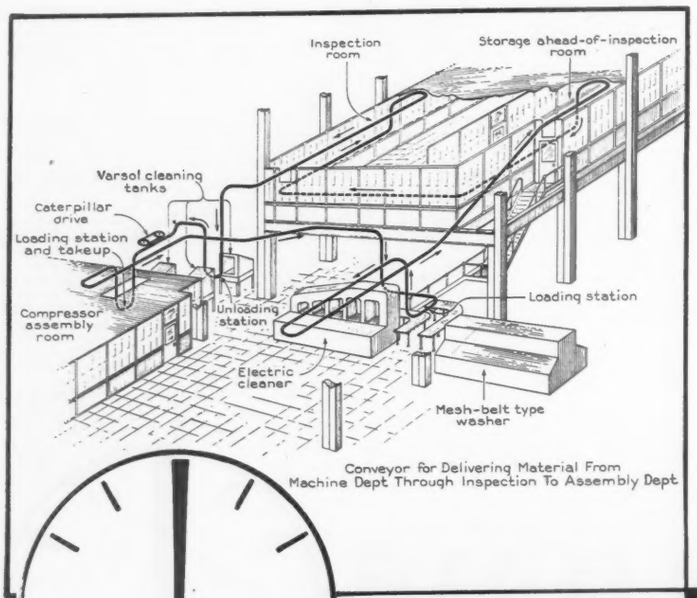
ALLIS-CHALMERS

MILWAUKEE · WISCONSIN

SINGLE-STAGE DOUBLE-SUCTION PUMPS • CLOSE-COUPLED SINGLE-STAGE SSUnit PUMPS • MULTI-STAGE PUMPS • PAPER STOCK PUMPS • MIXED FLOW AND AXIAL FLOW PUMPS • AND SPECIAL DESIGNS FOR UNUSUAL APPLICATIONS

courses in the factory school curriculum, are available to all factory employees. In the motion economy classes the only limit placed on enrollment is that there shall be a sufficient number of applicants in one department, or on related types of work, to form a class. Some typical groups who have taken the course up to the present time include drill-press, milling-machine, and gear-hobber operators, precision grinders, bench workers, subassemblers, punch-press operators, and final assemblers.

Classes are held outside regular working hours. This is practicable because they are all on a purely voluntary basis. Classes for day-shift employees are held once a week for one hour, either immediately following the regular working day or in the early evening. Classes for night-shift employees are held in the late afternoon immediately preceding the starting time. The groups meet in the classrooms provided in the modern school building which is located at our factory for use during the daytime for sales and service school purposes.



Conveyor for Delivering Material From Machine Dept Through Inspection To Assembly Dept

HIGH TIME

No use trying to estimate all the money you've lost in the past by not having materials moved through your plant on Webb Conveyors—but it's high time you did something to prevent further waste of your own profits. For each time any article is moved in production, its cost to the manufacturer and consumer alike is increased without one penny having been added to its value.

Boost sales, production, employment and profits by lowering material moving costs to a very minimum. Let a Webb Engineer offer suggestions. The service is free and there is no obligation.

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TRADE LITERATURE

Air Filters—Bulletin P-405-14, on Permo air filters.—Independent Air Filter Co., Inc., 228 North La Salle St., Chicago.

Barrel Rack—Bulletin 406, showing drum and barrel racks.—Barrett-Cravens Co., 3255 West 30th St., Chicago.

Cable—Bulletin GEA2623, on varnished-cambric insulated cable.—General Electric Co., Schenectady, N. Y.

Casters and Trucks—Catalog No. 38CG-2, on line of casters, trucks and pneumatic wheel equipment.—Saginaw Stamping and Tool Co., Saginaw, Mich.

Conductor Supports—Price List No. 31-G-1, on conductor supports for crane application.—Delta-Star Electric Co., 2400 Block, Fulton St., Chicago.

Controller—Catalog N-00B, on Micromax Pneumatic Control.—Leeds & Northrup Co., 4902 Stenton Ave., Philadelphia.

Controllers—Supplement to catalog 101-R, describing manual bypass for Fulscope Micromax controllers.—Taylor Instrument Cos., Rochester, N. Y.

Conveyors—Catalog No. 2, on conveyors for steel mills and foundries.—Standard Conveyor Co., North St. Paul, Minn.

Cutting Oils—Booklet, title "The Story of Sulphurized Cutting Oils."—D. A. Stuart Oil Co., 2729 South Troy St., Chicago.

Dust Separator—Bulletin No. 274, on Type W Roto-Clone dust precipitator.—American Air Filter Co. Inc., Louisville, Ky.

Fire Protection—1938 list of inspected fire protection appliances.—Underwriters' Laboratories, Inc., 161 Sixth Ave., New York.

Fuses—Bulletin FR, on Fuse Reducers for use where lower fusing is wanted without changing fusing gaps.—Kolton Electric Mfg. Co., 123 New Jersey Railroad Ave., Newark, N. J.

Gages—Folder, on Crobalt thread plug gages.—Detroit Tap and Tool Co., 8432 Butler, Detroit.

Generators—Bulletin GEA-432C, on Type CD d.c. generators and exciters.—General Electric Co., Schenectady, N. Y.

Generators—Bulletin No. 700, on low-voltage generators and motor-generator sets.—Columbia Electric Mfg. Co., 4519 Hamilton Ave., N. E., Cleveland.

Instruments—Bulletin B-2136, on socket instruments.—Westinghouse Electric & Mfg. Co., East Pittsburgh.

Instruments—Brochure, telling of instruments and the importance of measurement.—General Electric Co., Schenectady, N. Y.

Instruments—Two bulletins: GEA-2821, on Type AD-6 easy-reading switchboard instruments; GEA-2822, on small panel instruments.—General Electric Co., Schenectady, N. Y.

Nuts—Catalog, on line of stop nuts.—Elastic Stop Nut Corp., 1001 Newark Ave., Elizabeth, N. J.

Packing Glands—Folder, on conical, self-aligning packing glands.—Crane Packing Co., 1800 Cuyler Ave., Chicago.

Potentiometers—Bulletin No. 507, describing Pyromaster round-chart potentiometers.—The Bristol Co., Waterbury, Conn.

Pulleys—Folder, on pulleys and flexible couplings.—The Congress Tool & Die Co., Inc., 9030 Lumpkin Ave., Detroit.

Pumps—Booklet, describing pumps for all purposes.—De Laval Steam Turbine Co., Trenton, N. J.

Pumps—Bulletin No. 3000, on self-priming centrifugal pumps.—The Deming Co., Salem, Ohio.

Pyrometers—Leaflet A-382-S, on wall and portable indicating pyrometers.—Thwing-Albert Instrument Co., 3339-41 Lancaster Ave., Philadelphia.